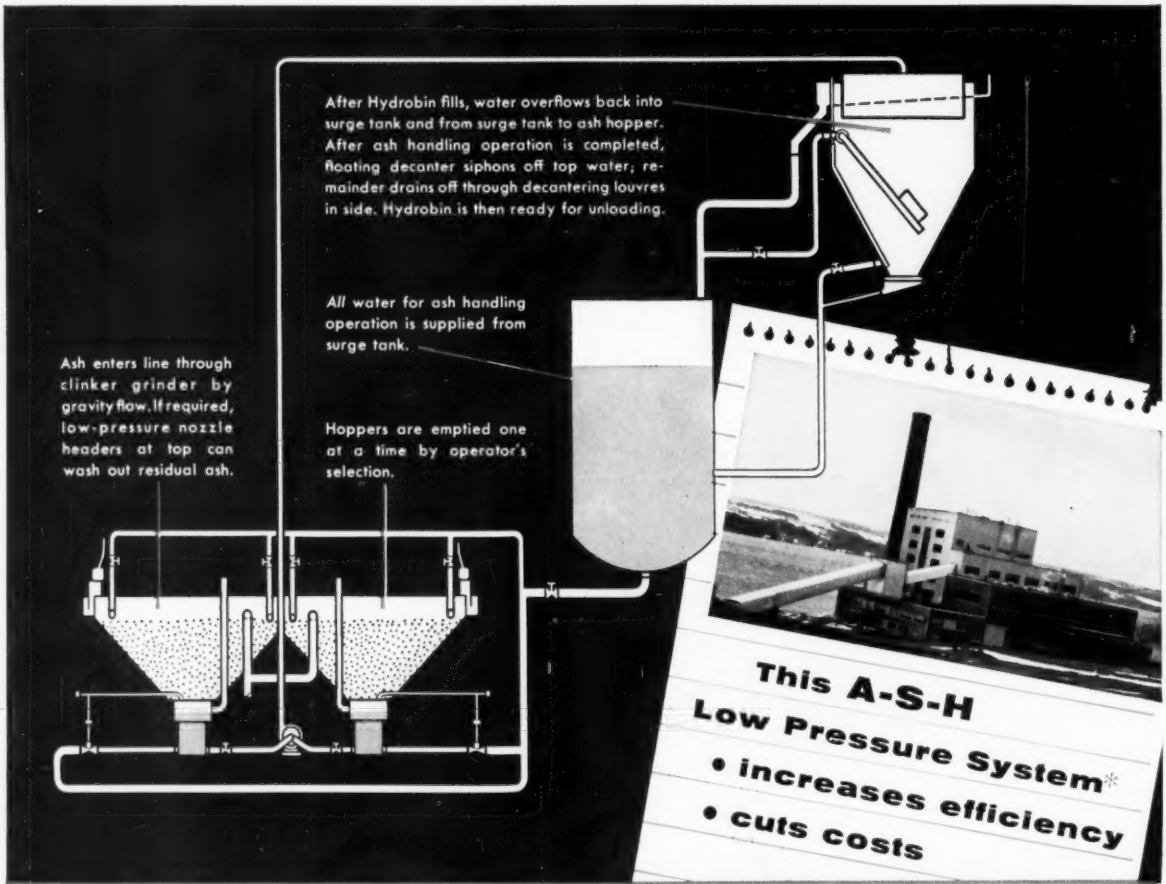
75th Year Building a more powerful America

Power

JULY 1957
ONE DOLLAR
A McGRAW-HILL PUBLICATION

Tiny germanium rectifiers gang up for 35,000-kw load ▸ 73


After Hydrobin fills, water overflows back into surge tank and from surge tank to ash hopper. After ash handling operation is completed, floating decanter siphons off top water; remainder drains off through decantering louvres in side. Hydrobin is then ready for unloading.
All water for ash handling operation is supplied from surge tank.
Ash enters line through clinker grinder by gravity flow. If required, low-pressure nozzle headers at top can wash out residual ash.
Hoppers are emptied one at a time by operator's selection.
This A-S-H Low Pressure System*
• increases efficiency
• cuts costs

at the Milliken Station of the New York State Electric & Gas Corp.

On beautiful Cayuga Lake, just outside Ithaca, N. Y., the New York State Electric & Gas Corporation built their new Milliken Power Station. To minimize water pollution by ash from their 1,000,000 lbs-per-hr boiler, A-S-H engineered, built and supervised the installation of this *unusual* Low Pressure Hydraulic Materials Handling System for transporting bottom ash. Fly ash is handled by an A-S-H Pneumatic System.

This bottom ash handling system began saving money for the New York State Electric & Gas Corp. *immediately*. The use of low pressure water recirculation instead of the "usual" high pressure sluicing system saved 200 hp in power requirements.

This A-S-H low pressure system operates with unusual efficiency and requires low maintenance. Nowhere is high pressure water used. One Hydroseal Ash Pump serves the dual-bottom hopper. The only water entering the system is make-up for water lost through evaporation or absorbed by the ash, and clear water for the pump seal.

Because this system is so unusual, we have reprinted an article that describes and pictures the Milliken Station installation in detail. A copy of this will be forwarded to you on request.

This installation typifies the A-S-H approach to any problem. Where possible our engineers specify A-S-H standard components—but we will design and build an entirely new type system if the problem dictates.

A-S-H Engineers are anxious to tackle *your* ash handling problem, no matter how large or small it may be. The knowledge and experience that developed this system is ready to go to work for you tomorrow. Contact us—today.

* *A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.*

MATERIALS HANDLING SYSTEMS

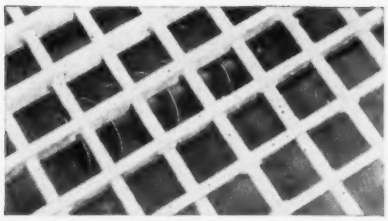
"Hydrojet" *hydraulic*

"Hydrovac" *pneumatic*

the **Allen-Sherman-Hoff** company

259 E. Lancaster Ave., Wynnewood, Pa.

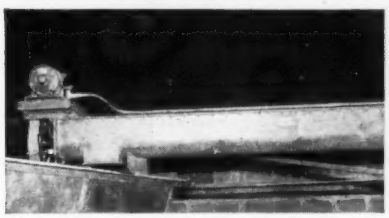
Offices and representatives in principal cities



TRUCK HOPPER at foot of bucket elevator receives coal direct from trucks.

SCREW FEEDER conveys coal from hopper to bucket elevator.

ENCLOSED SCREW CONVEYOR moves coal from elevator to 40-ton storage bin.



STOKER HOPPER (indoors) is filled by screw conveyor from outside storage bin.

MECHANIZED COAL HANDLING SYSTEM at this plant is designed and equipped by Link-Belt to handle 13 tph of minus 1½-in. stoker coal which is delivered by truck.

Why process plants like this...needing uninterrupted steam supply...

come to LINK-BELT for coal handling

Reliable system answers demands of continuous processing

MAINTAINING round-the-clock steam output, this coal handling system shows how Link-Belt duplicates big power plant dependability for small boiler houses. Whether you handle one ton or 2,000 tons of coal per hour, you can rely on this single source for all your coal handling needs—a complete system or an individual component.

In addition, Link-Belt offers you vast experience in plant design. We will work with you and your engineers from planning through erection to bring you lowest per-ton handling costs. For complete information, call your nearby Link-Belt office. Or write for Book 2410.

14,612

LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

DE LAVAL OPPELLER PUMPS

last longer... cut maintenance costs

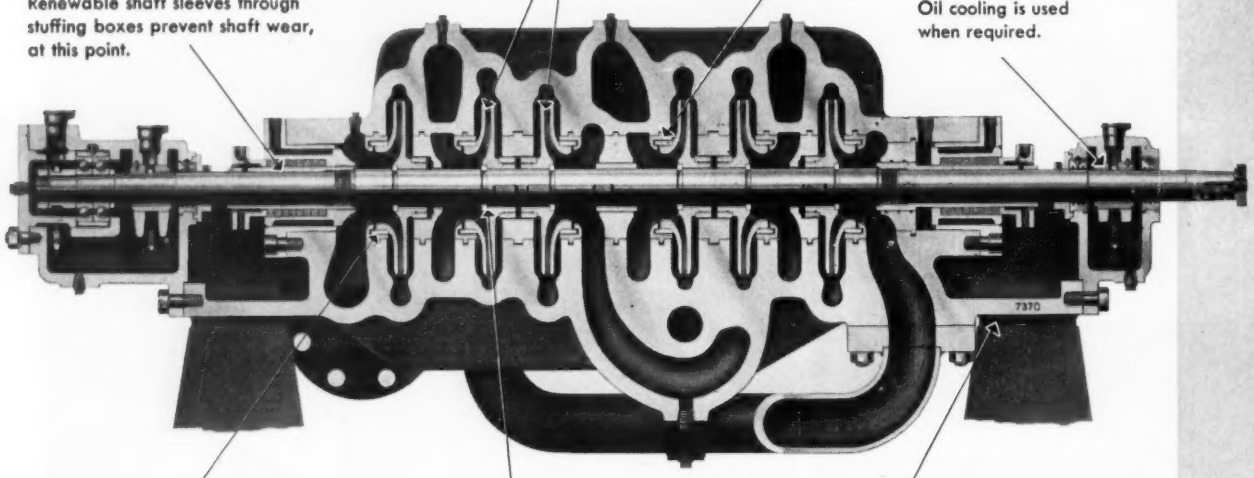
Stages are arranged to reduce differential pressures between stages. This insures permanent sealing at the casing-joint and at interstage diaphragms.

Pairs of back-to-back impellers balance axial thrust. One-purpose thrust bearing carries no radial load, maintains axial alignment.

Labyrinth wearing rings permit safe clearances and reduce wear.

All bearings are ring-oiled, sealed against contamination by water or dust. Oil cooling is used when required.

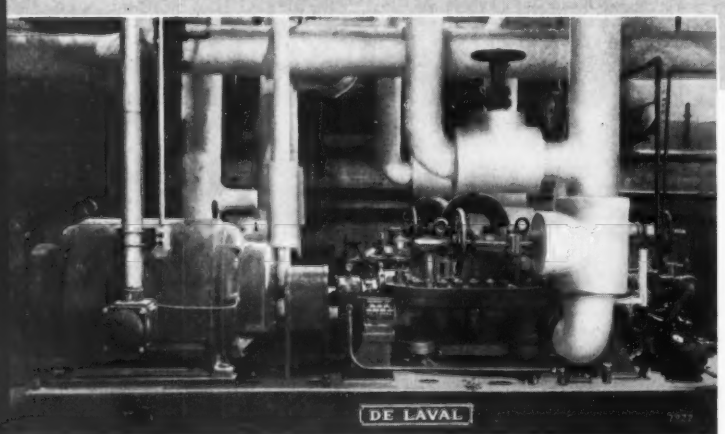
Renewable shaft sleeves through stuffing boxes prevent shaft wear, at this point.



Threaded impeller wearing rings make replacement easy without heating or damage to impellers.

Individual impeller mountings, with split locating rings, make interstage shaft sleeves unnecessary. Impellers can't shift with shaft expansion and contraction.

Casing support insures coupling alignment at any operating temperature.



Here are two De Laval 6-stage Oppeller Pumps used for boiler feed service in an industrial installation.

The design features above show clearly why De Laval Oppeller Pumps stay on the line longer and cost less to maintain. These pumps are used for boiler feed, hydraulic systems, descaling spray, mine dewatering, refinery oil pumping and similar services.

De Laval Oppeller Pumps are available in sizes from 2 to 4 inches and 2 to 8 stages; capacities to 1000 gpm, pressures to 1200 psig and temperatures to **350F.**

DE LAVAL *Oppeller Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

Power

JULY 1957 • VOLUME 101 NUMBER 7

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Print order this issue: 49,595

GERMANIUM is climbing into the high-capacity league, as shown on this month's cover. Every tray in the jumbo unit, above, boasts 200-amp capacity and 96% efficiency with four cells in series. Each of the 18 cabinets in this 35,000-kw unit houses four ac 3-phase circuits with six trays forming a bridge. This tallies up to nine bridges per circuit, or 216 trays. Today's thinking on germanium's potential begins on p 73.

Next month . . .

Piping roughness plays hob with the discharge coefficient of fluid meters. To shed light on the problem, upstream calibration tests were made. August 3-pager outlines quantitative results.

Feedwater heaters, with all-welded construction, are expected to cut maintenance while simplifying design problems in face of rising temperatures and pressures. Upcoming article contains the dope on a New Jersey installation.

Canned motors, used in nuclear reactor plants, now are being developed to serve equally well in nonatomic applications. Get to know their design intricacies next month; you may be running up against them real soon.

. . . and a future month

75th Anniversary Issue will wrap up in 200-plus editorial pages the power-field picture—yesterday, today and tomorrow. Included will be a 48-p staff report on "Energy." It's coming in September, don't miss it!

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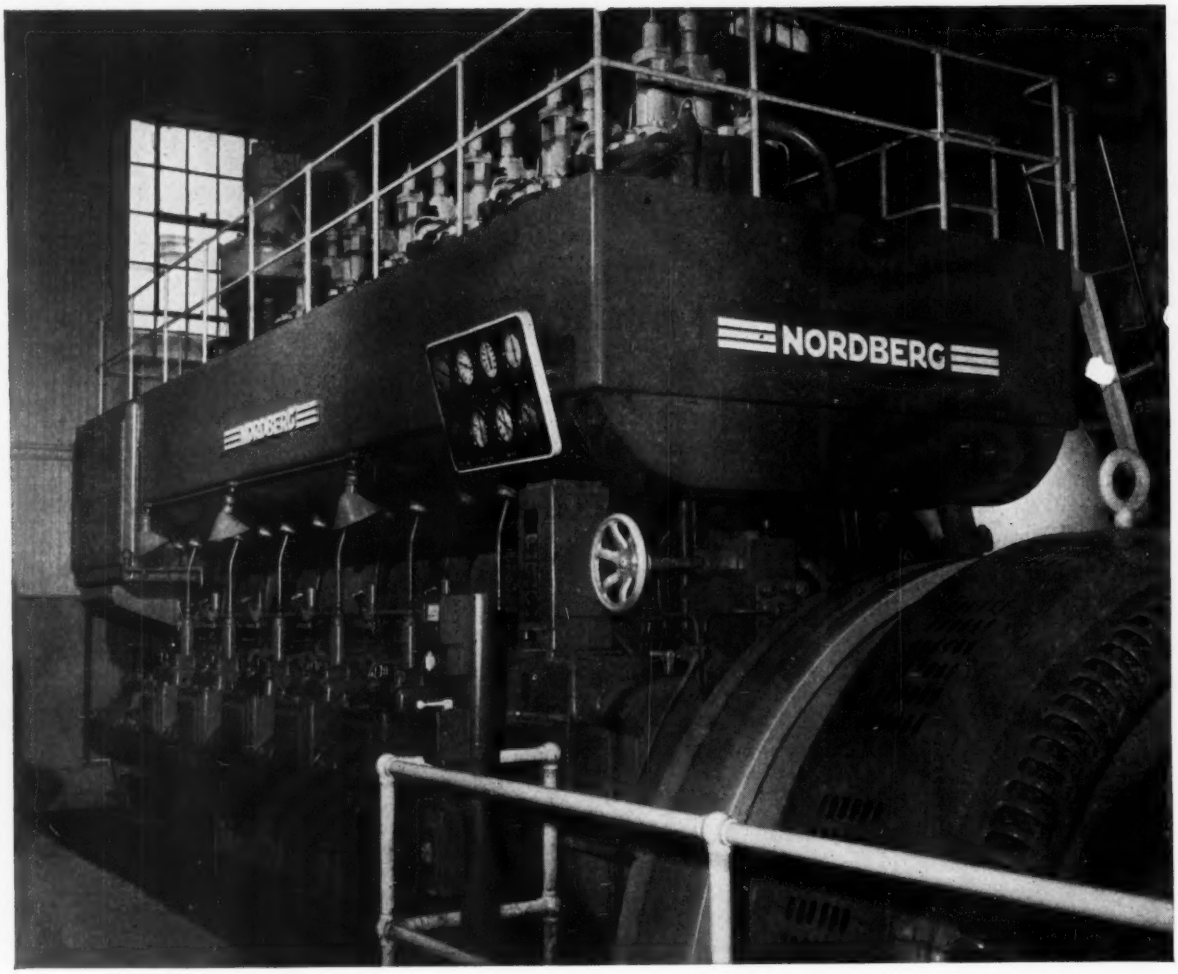

Make sure you get the power you pay for

When fuel and maintenance bills get out of hand and power's not up to par, chances are your oil is the culprit. Let your Texaco Lubrication Engineer recommend the proper grade of *Texaco Ursa Oil.*

Texaco Ursa Oils keep diesel systems running clean for full compression and complete combustion . . . prevent harmful deposits in the combustion chamber, in crankcase and on valves. They help minimize ring, cylinder and bearing wear—all of which adds up to full power on less fuel and lower maintenance costs.

For over twenty years more stationary diesel horsepower in the United States has been lubricated with Texaco than with any other brand.

There is a complete line of *Texaco Ursa Oils* to meet the requirements of all diesel, gas and dual-fuel engines.

Just call the nearest of more than 2,000 Texaco Distributing Plants in the 48 States—or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

speaking of **Power**

Lou Rowley: *Power's new Associate Publisher and Editor*

On July 1st Editor Lou Rowley shoulders the dual responsibility of Associate Publisher and Editor. This latest step up the publishing ladder comes to Lou just six weeks short of his 20th anniversary on the POWER staff. Shelton Fisher, while assuming still further responsibilities within McGraw-Hill, continues as Publisher of POWER.

Lou's latest promotion tops a two-decade climb from Assistant to Associate Editor, Managing Editor, Executive Editor and, in September 1954, to Editor, succeeding Phil Swain. We who work with Lou every day can't visualize a better primed candidate to step into the new spot. From the Editor's chair Lou has spent years spearheading an unremitting drive for the last ounce of editorial quality, for ever-greater engineering service to readers in ever-more-original journalistic form. His ever-expanding professional contributions have won him a wide circle of power-field friends throughout the United States and Canada.

On the home front, Rowley's son, Bob, is showing signs of adopting his father's bent for success: The lad recently earned a McGraw-Hill Merit Scholarship. And he won his laurels in nation-wide competition with 162,000 high school seniors coming from some 12,500 schools.

Highest honors came again to POWER when our staff report *Corrosion* (Dec 1956) was selected by our editorial peers as the best single article published in an industrial magazine during 1956. Award was made as part of the 19th Annual Business Paper Editorial Achievement Competition, sponsored by the magazine *Industrial Marketing*. We are mighty proud this report was singled out to stand alongside several other POWER reports similarly recognized in past years.

Reader's letters and requests for reprints are a form of recognition highly regarded by editors. To date we've received requests for over 6000 reprints of *Corrosion* along with numerous letters commenting on its value to power-service engineers in ". . . bringing the latest thinking to bear on corrosion problems in the plant."

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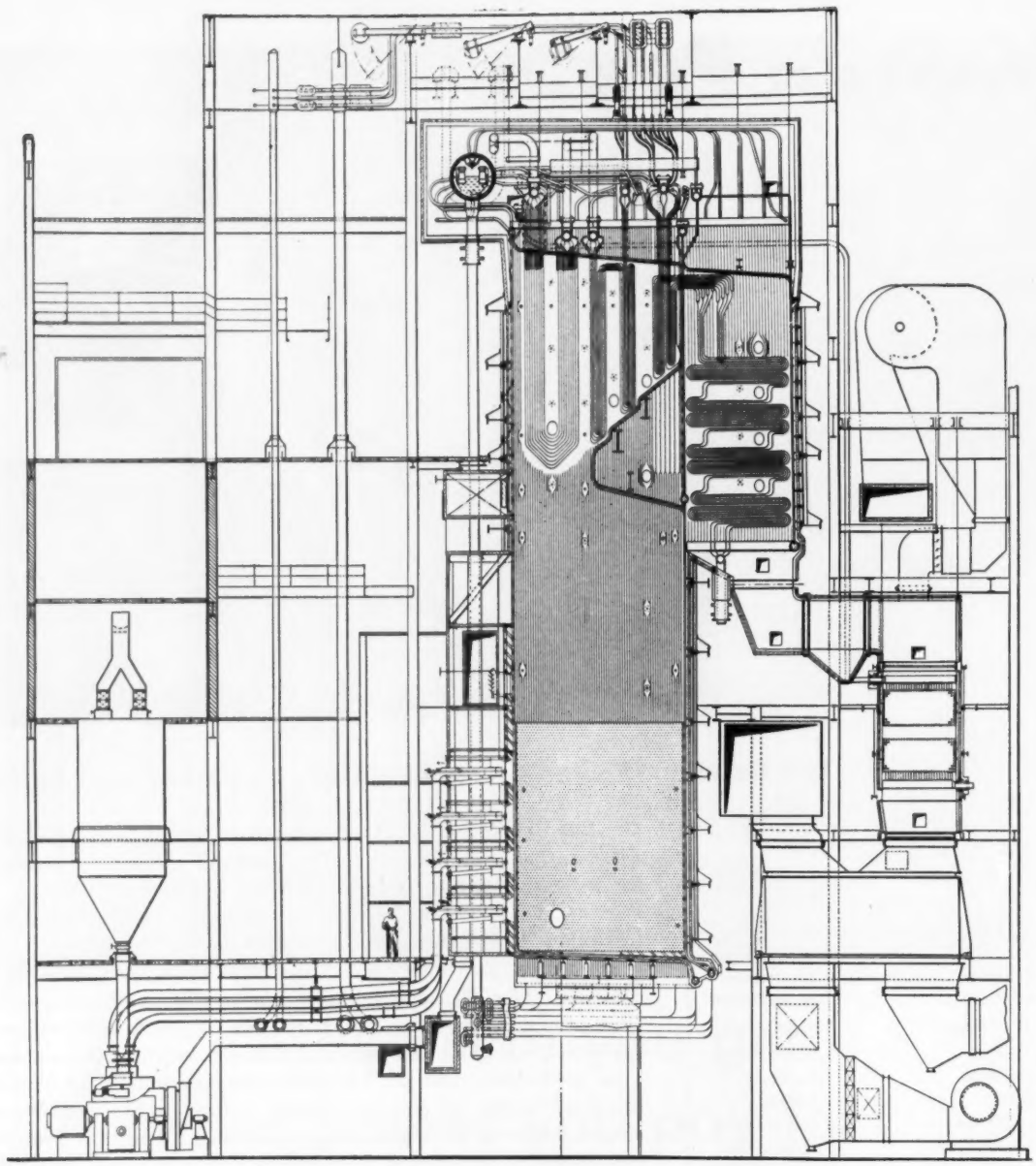


Latest unit for Burlington Station, Public Service Electric & Gas Company has a capacity of 1,350,000 lb of steam per hr. Comprehensive circulation tests on this unit, plus more than a year of sustained performance, proved that natural circulation boilers can operate easily with drum design pressures of 2800 psi, for throttle conditions over 2400 psi.

B&W NATURAL CIRCULATION BOILERS ABOVE 2600 PSI DESIGN PRESSURE

NAME OF UTILITY	STATION	NO. UNITS	DES. PRESS. psi	THROTTLE PRESS. psi	TOTAL TEMP. F	REHEAT TEMP. F	TOTAL KW
Indiana & Michigan Electric Co.	Twin Branch	1	2650	2335	940	900	76,500
Public Service Electric & Gas Co.	Burlington	1	2700	2350	1100	1050	200,000
Public Service Electric & Gas Co.	Linden	1	2700	2350	1100	1050	225,000
Southern California Edison Co.	Huntington Beach	2	2700	2400	1050	1000	400,000
Virginia Electric & Power Co.	Bremo	1	2700	2400	1000	1000	150,000
International General Electric Company	Chiba	1	2700	2400	1060	1010	175,000
Memphis Light, Gas & Water Div.	Thos. H. Allen	3	2825	2400	1053	1053	862,500
Detroit Edison Co.	St. Clair	1	2700	2400	1050	1000	325,000
Virginia Electric & Power Co.	Portsmouth	1	2700	2400	1000	1000	150,000
Southern California Edison Co.	Mandalay	2	2700	2400	1050	1000	400,000
Pacific Gas & Electric Co.	Pittsburg	2	2725	2400	1050	1000	660,000
TOTAL CAPACITY SERVED							3,624,000

If You Are Considering...

2400 PSI THROTTLE CONDITIONS

You'll Want to Investigate B&W's Unique Experience

There's a reason why so many progressive utility companies and their engineers, thinking of turbine throttle conditions of 2400 psi, have turned to B&W. It is the unique record of performance of B&W high pressure natural circulation boilers.

Simplicity of installation and operation has been brought to high pressure steam generation by B&W natural circulation boilers. They have lower operating costs because no machinery requiring power and maintenance is needed for circulation.

Long range operating experience—since 1939—has been gained with natural circulation high pressure boilers operating above 2000 psi. Operators' success with natural circulation boilers is due to the B&W Cyclone Steam Separator, and a design which makes liberal use of outside downcomer capacity and provides proper balance of makeup and riser tubes.

Clean turbines are an extra plus value. Cyclone Steam Separators not only maintain good circulation, but, used with Steam Washers, they maintain exceptionally clean turbines. At one plant, where a B&W Radiant Boiler has been on the line constantly for a year, the turbine manufacturer reports that the turbine is the cleanest high pressure unit his engineers have ever seen. And tubes in the high duty part of the furnace are as clean internally as the day they were installed.

B&W first designed natural circulation boilers for operation at drum pressures over 2000 psi nearly 20 years ago. Today 86 B&W natural circulation boilers with these high design pressures are in operation and 52 more are being built.

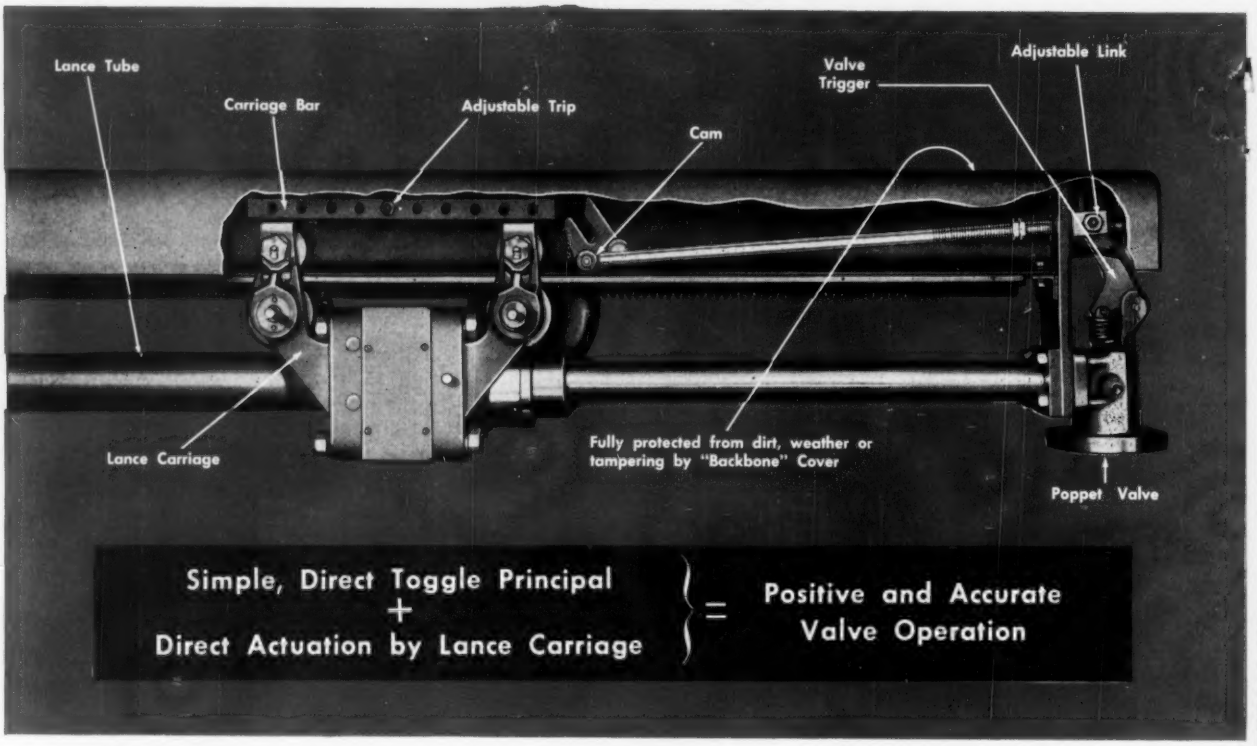
The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-845-CS

BABCOCK & WILCOX

BOILER DIVISION

MECHANICALLY OPERATED



SERIES 300 IK—LONG RETRACTING BLOWER

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Backbone and Protective Cover
- Compact, Accessible Electric Power and Control Terminal Facilities
- Front End Single-Motor Drive
- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
- Positive Gear Carriage Drive
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

Diamond

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited, Windsor, Ontario

POPPET TYPE VALVE

(WITH ADJUSTABLE PRESSURE CONTROL)

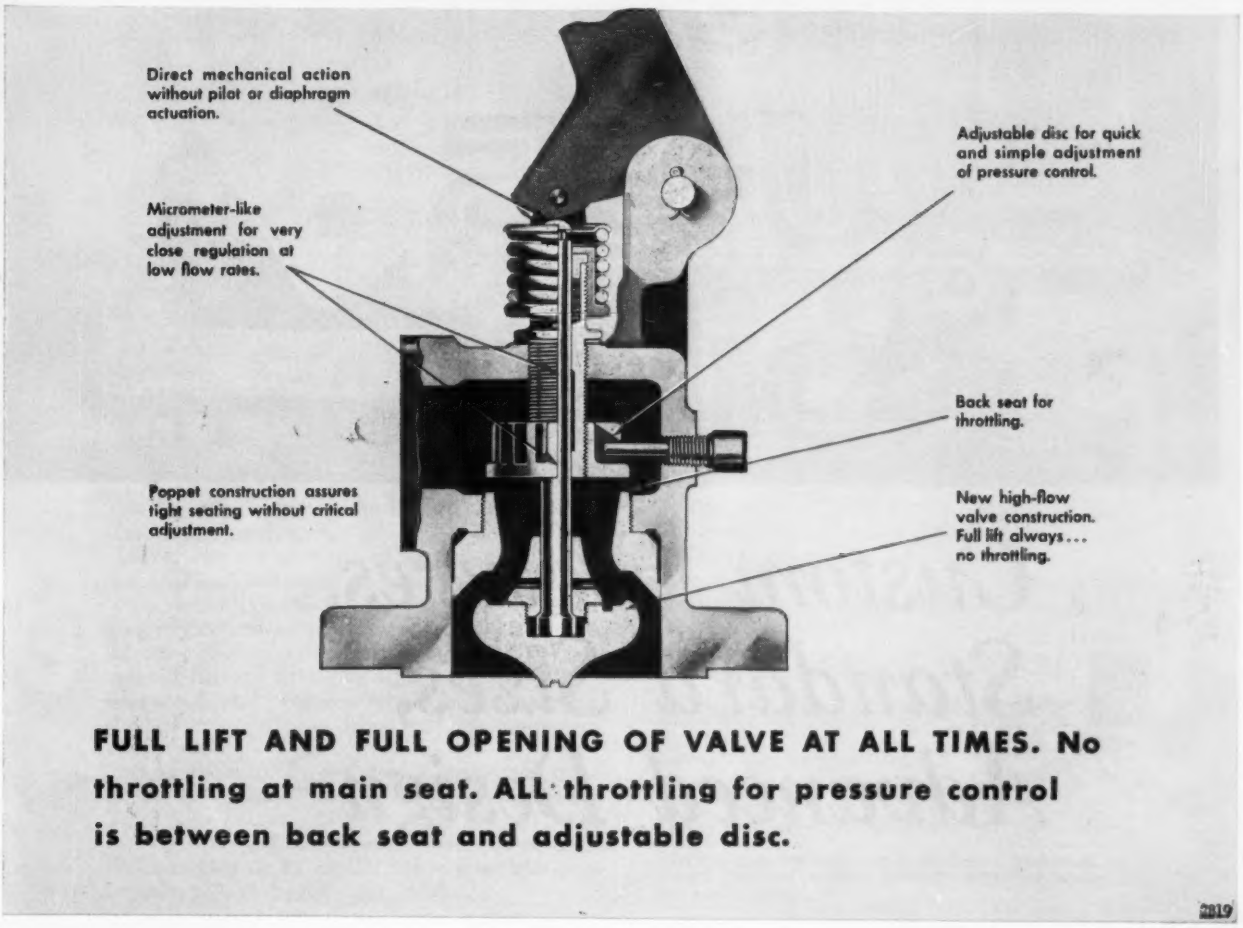
additional important features of the

New Diamond Series 300 IK
LONG RETRACTING BLOWER

This valve was adopted for the new Series 300 IK because long experience has proved it the most satisfactory of all designs for severe blower service. More than 300,000 of this basic design are in use on various Diamond Blowers and have established notable service records. A recent improvement is more streamlined flow contours that permit higher flow rates with less pressure drop.

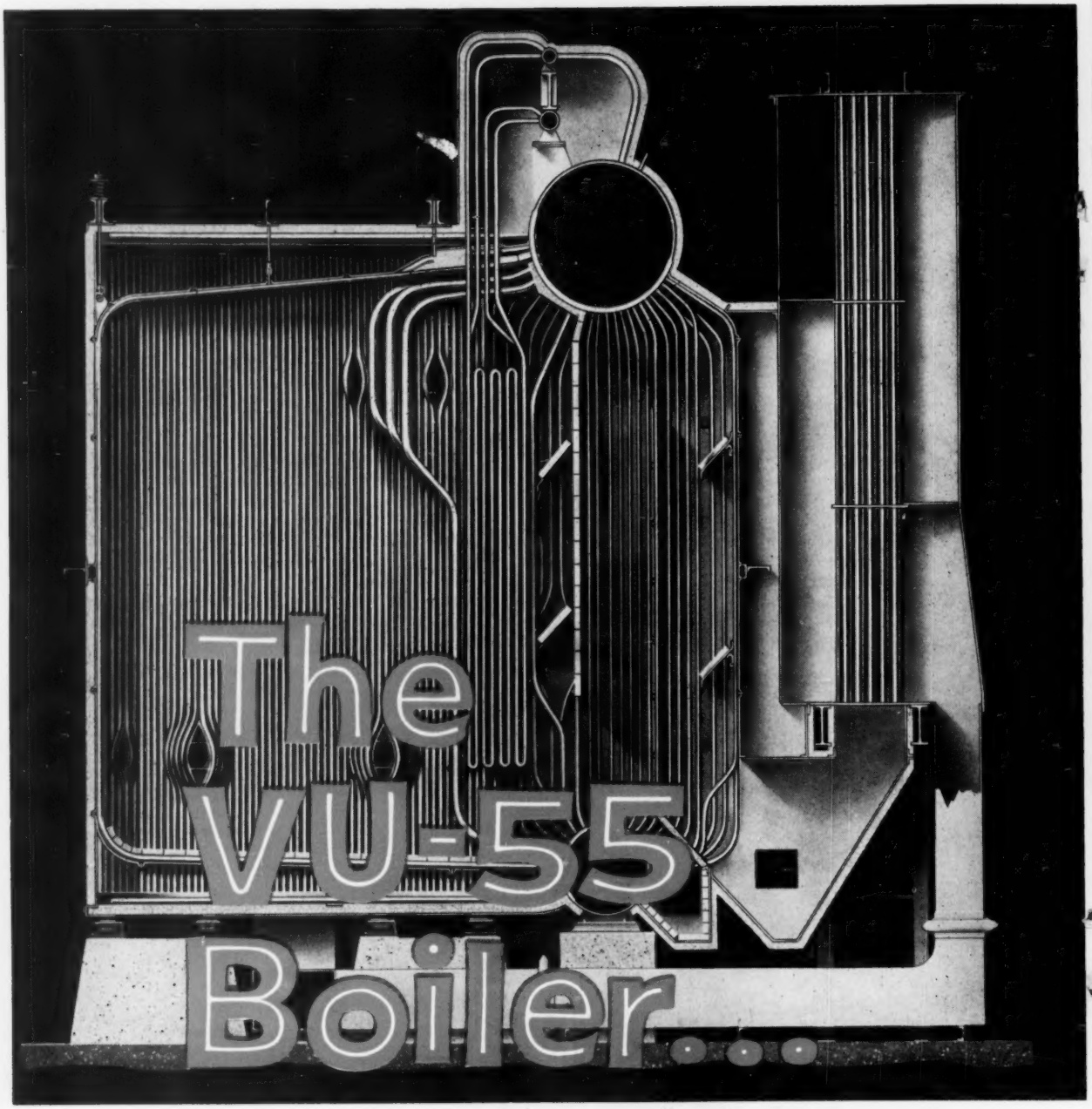
The direct mechanical linkage for actuating the valve offers the advantages of greater reliability and safety . . . in addition to more accurate control. Numerous other important features of the Series 300 IK are listed at the bottom of the left hand page. These are the reasons why this blower is establishing a new standard of efficiency, economy and dependability in cleaning heating surfaces that require a long retracting blower.

Bulletin 2111 tells much more about the Series 300 IK; ask your local Diamond office or write directly to Lancaster for a copy.

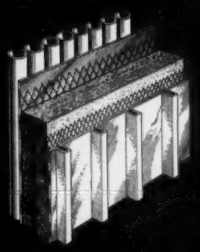

Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Poppet construction assures tight seating without critical adjustment.
Adjustable disc for quick and simple adjustment of pressure control.
Back seat for throttling.
New high-flow valve construction. Full lift always... no throttling.

FULL LIFT AND FULL OPENING OF VALVE AT ALL TIMES. No throttling at main seat. ALL throttling for pressure control is between back seat and adjustable disc.

2819



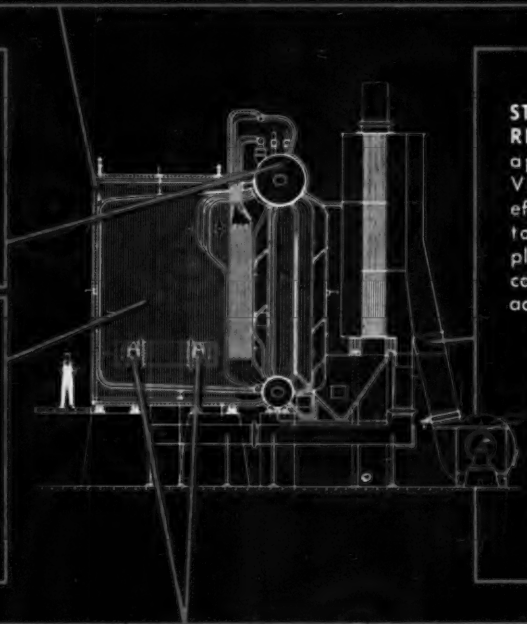
Custom Features, Standard Sizes, Advanced Design



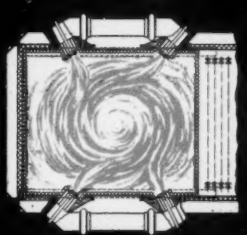
DOUBLE WALL, PRESSURE-TIGHT CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this double-wall construction.

HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq. ft. are higher.



STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

The VU-55, newest of the C-E line of Vertical Unit Boilers, represents the closest approach to central station performance yet achieved in standardized boilers in its capacity range.

Its design combines a number of time-tested and service-proved features, such as Tangential Burners, double wall, pressure-tight casing, and tangent furnace tubes. In addition, this bottom-supported unit requires no outside supporting steel, is economical of space and streamlined in appearance.

It is available in 5 sizes for capacities from 50,000 to 120,000 lb per hour. It is designed for 3 pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 750 F. Either a tubular or a regenerative air heater is available.

The VU-55 Boiler is symmetrical in design, performs efficiently over a wide range of output, and is easy to operate and maintain.

It is, in fact, the boiler with the custom features and the advanced design.

COMBUSTION ENGINEERING

B-978

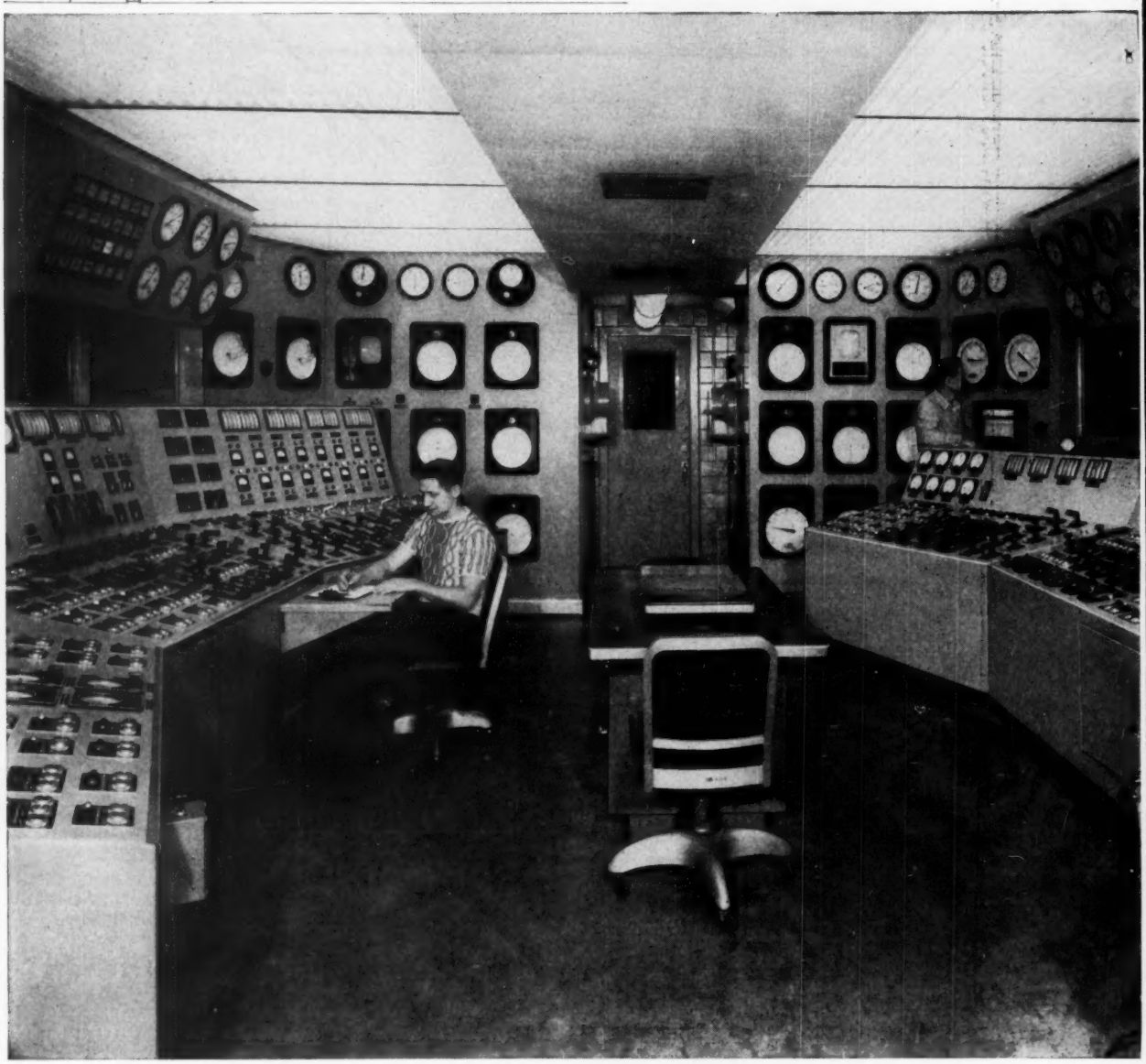
Combustion Engineering Building

200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

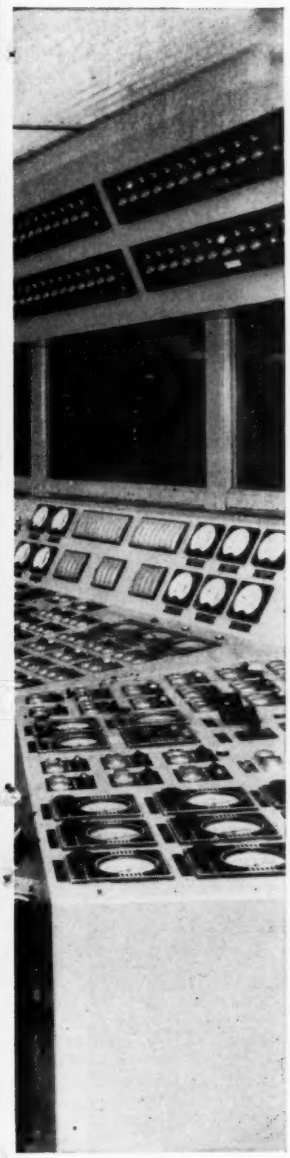
all types of steam generating, fuel burning and related equipment; nuclear reactors; paper mill equipment; pulverizers; flash drying systems; pressure vessels; soil pipe.

14 out of the 15



The steam control room for units 3 and 4 of the Eastlake Plant of The Cleveland Electric Illuminating Company. Eastlake uses Bailey Meters and Bailey Controls for Combustion, Feed Water and Steam Temperature. The FPC reported a 1955 heat rate at Eastlake of 9,336 Btu per kwhr, making it the seventh most efficient plant in the United States.

"most efficient*" plants use Bailey Meters and Controls



How's that for a vote of confidence! In the electric power industry, quality and dependability of equipment are paramount and 14 out of the top 15 power stations on the FPC's 1955 list chose Bailey Meters and Controls. Nine of these 15 chose Bailey equipment exclusively!

For breadth of product line, depth of experience, size and quality of field service organization, no one offers more to the power industry than Bailey. And the time to contact Bailey is during the early planning stage, when our recommendations can save time, trouble and money. Our engineers are at your service.

* 15 MOST EFFICIENT PLANTS

1955 Heat Rates Reported by FPC

	Btu/kwhr	Meters	Comb. Cont.	Feed Water Cont.	Steam Temp. Cont.
1. Kyger Creek (Ohio Valley Electric Corp.)	9,110	B		B	B
2. Clifty Creek (Indiana-Kentucky Electric Corp.)	9,143	B	B	B	B
3. Kanawha River (Appalachian Electric Power)	9,151	B	B	B	B
4. St. Clair (Detroit Edison Co.)	9,220	B	B	B	B
5. Muskingum River (Ohio Power Co.)	9,234	B	B	B	B
6. Tanners Creek (Indiana & Michigan Electric Co.)	9,273	B	B	B	B
7. Eastlake (Cleveland Electric Illuminating Co.)	9,336	B	B	B	B
8. Philip Sporn (Ohio Power Co.)	9,341	B	B	B	B
9. Shawville (Pennsylvania Electric Co.)	9,368	B			B
10. Albany (Niagara Mohawk Power Corp.)	9,373				
11. El Segundo (Southern California Edison Co.)	9,417	B	B	B	B
12. Oak Creek (Wisconsin Electric Power Co.)	9,480	B	B	B	B
13. Kearney "B" (Public Service Electric & Gas Co.)	9,511	B		B	B
14. Dunkirk (Niagara Mohawk Power Corp.)	9,523	B	B	B	
15. Cromby (Philadelphia Electric Co.)	9,540	B		B	B

B — Bailey installation

A130-2

Instruments and controls for power and process

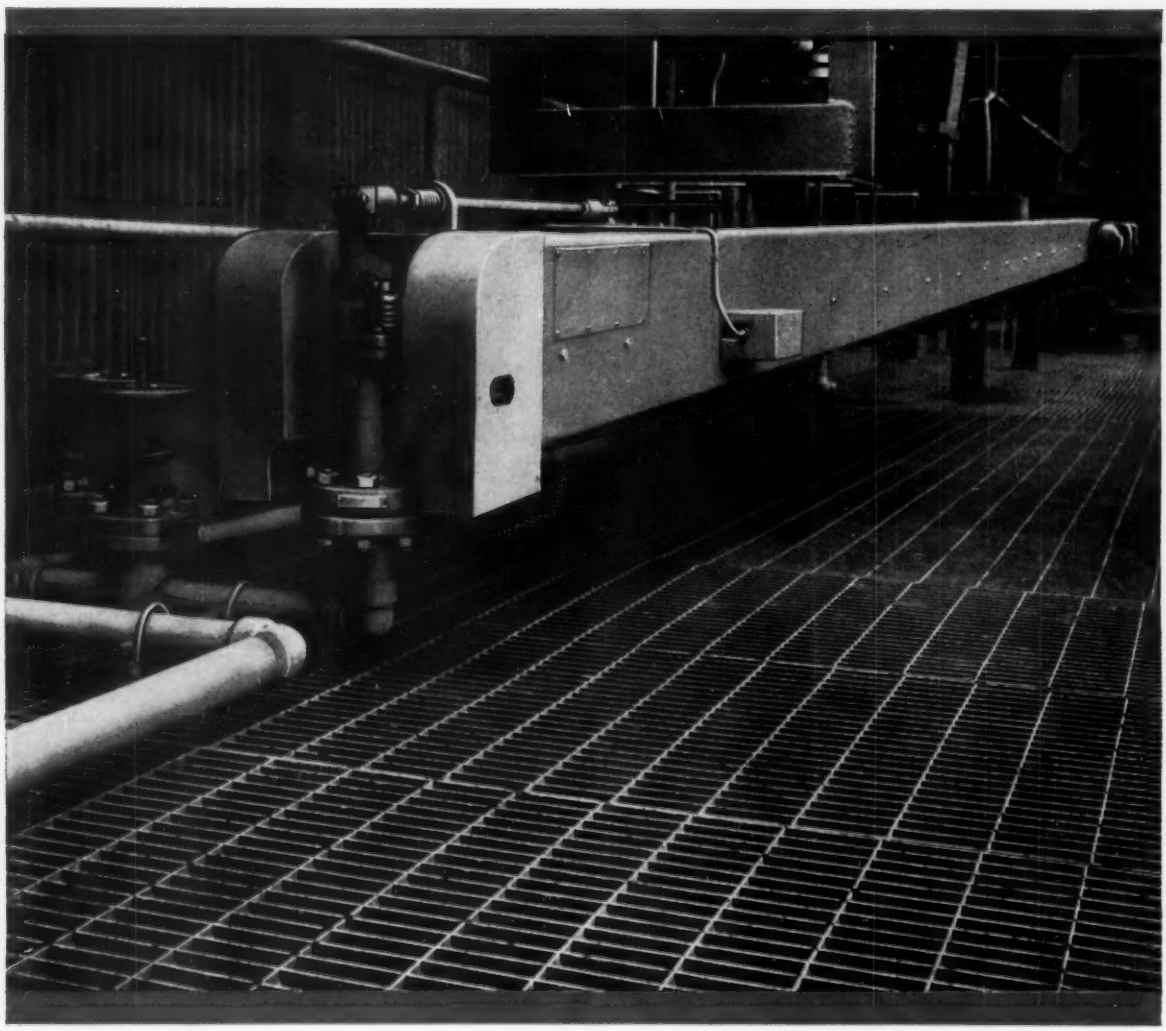
BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada — Bailey Meter Company Limited, Montreal

BAILEY METERS

Vulcan T-30 long cover record at Meramec Station!



This Vulcan T-30 long retractable soot blower has been in operation on Unit 1 at Meramec Station since May, 1956. Fuel for the Combustion Engineering boiler is pulverized coal. Burners are arranged for tangential firing and can be tilted for superheat control.

C-3447

retracts distance

A Vulcan T-30 long retractable soot blower is reaching more than 35 feet between two banks of the pendent secondary superheater on Boiler No. 1 in Meramec Station of Union Electric Company of Missouri. This Vulcan T-30 requires only one outboard hanger to support the extra-rugged framework. Lance travel and rotation are non-synchronized through two driving motors to produce a multi-helix cleaning path to cover different areas of the tube bank while extending and retracting.

Performance of this Vulcan T-30, which is located at the furnace exit where temperatures average 1910 degrees F., led to the selection of Vulcan T-30 blowers with 36-foot travel, RW-3E wall deslaggers and E-4-E rotaries—all under automatic-sequential control—for Meramec's new Unit 3, a Foster Wheeler boiler with separate furnaces, rated at 1,850,000 pounds per hour at 2150 psig and 1010 degrees F., with reheat to 1010 degrees F.

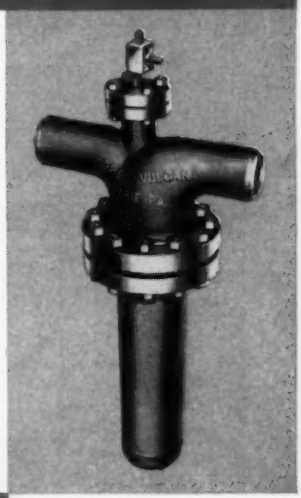
Whether your boiler is large or small, power or process, modern Vulcan soot blowers will help keep it operating at peak efficiency. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.

COPES VULCAN

BLAW-KNOX

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

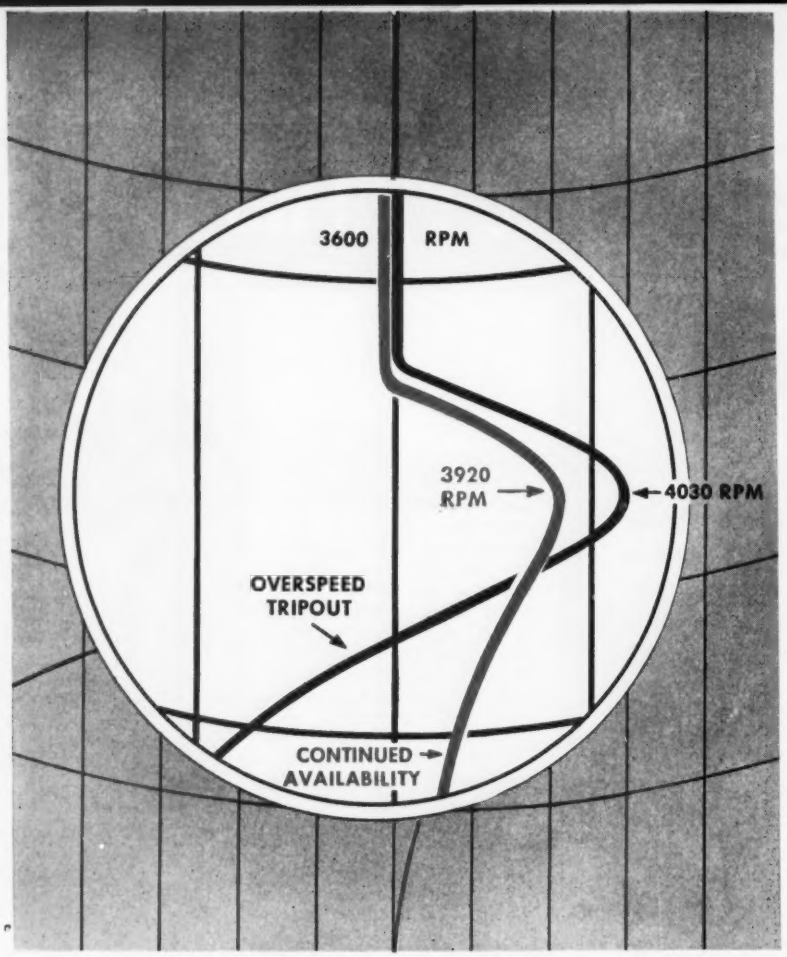
C-V NEWS NOTES



Copes-Vulcan Steam-Assist Desuperheater meets all specifications for conventional steam-atomizing type, yet normally uses assisting steam only on light loads where control is most difficult. Furnished with carburetor body as shown, or for in-line installation. Simple mechanical-atomizing types are also available. Bulletin 1024-A.

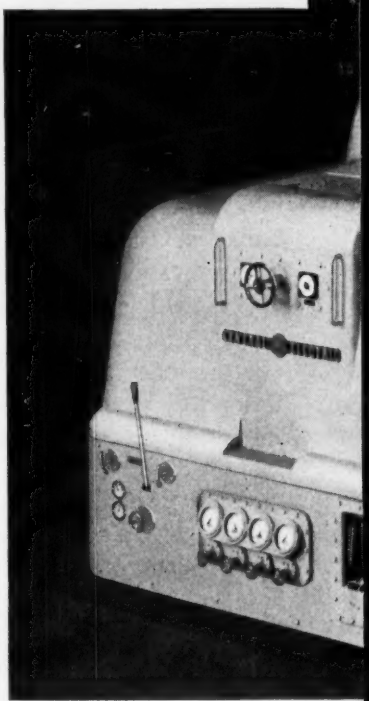
Unlimited pressures and sizes up to 16-inch, plus simplified design, are features of the new Copes-Vulcan Types CV-D and CV-P valves. Either diaphragm or piston types are available for pressure, temperature or liquid level control. Bulletin 1027.

Bulletin 1030 illustrates and describes the Vulcan T-30 long retractable soot blower, now successfully operating in temperatures up to 2150 degrees F. (radiant). Your Copes-Vulcan representative can give you a copy, or write direct to the factory.



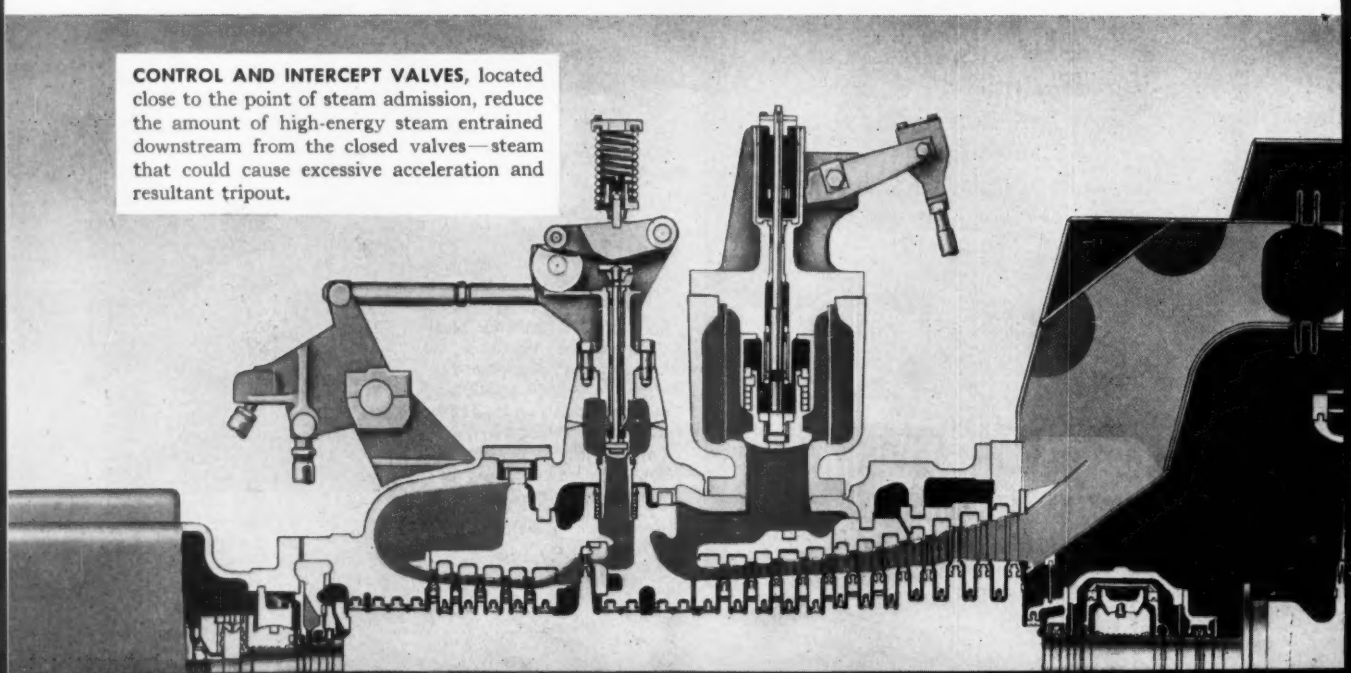
SENSITIVE GOVERNING SYSTEM helps avoid costly tripouts. The red curve, above, shows how a typical G-E reheat turbine stays below tripout speed by limiting speed to 3920 rpm during temporary system interruption. Without this split-second governing response, overspeed to 4030 rpm can result in costly shutdown.

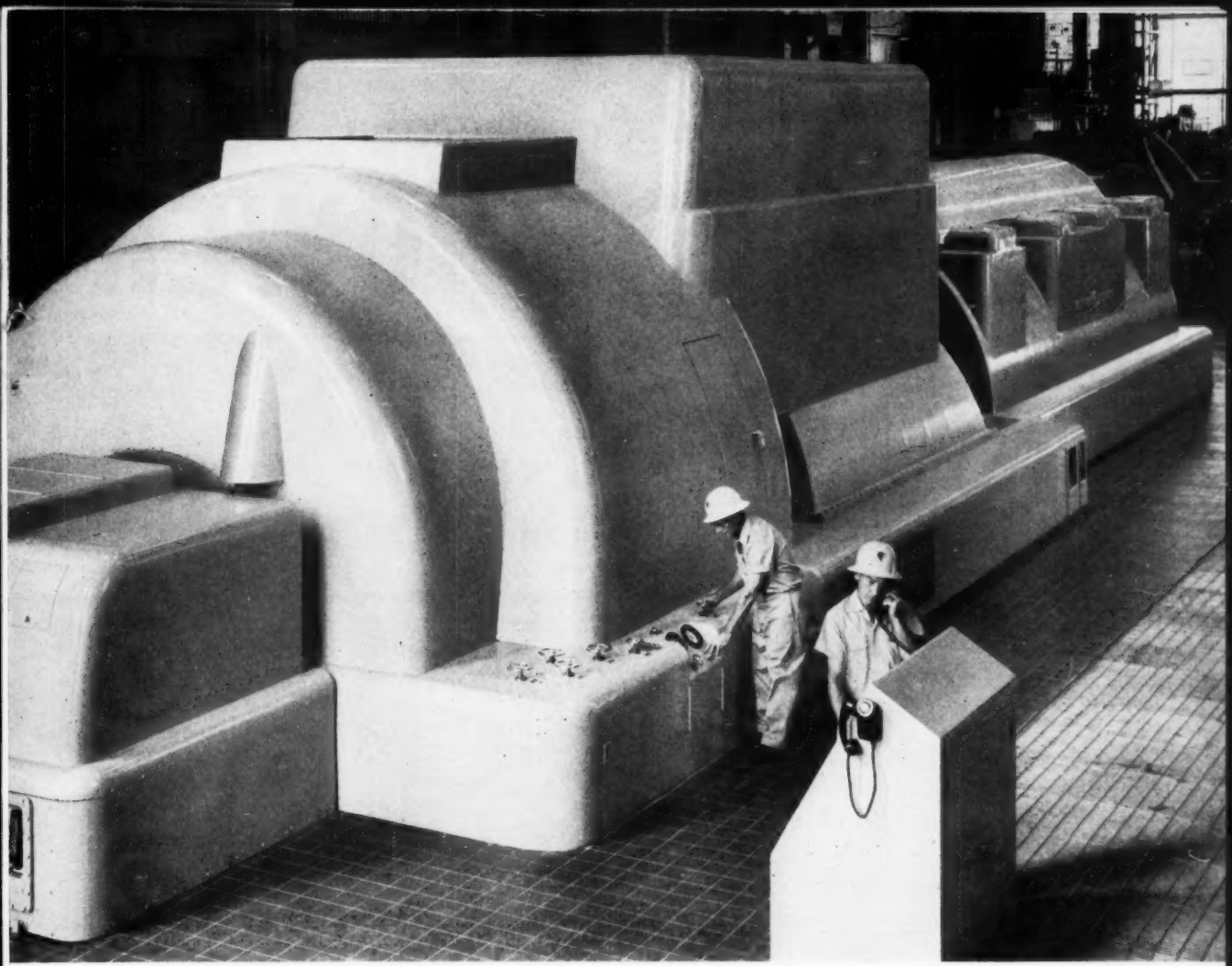
SPLIT-SECOND RESPONSE to system disturbances helps keep units like this on-the-line. Pictured here is a 150,000 kw reheat steam turbine-generator at Oklahoma Gas and Electric Company's Riverbank Station.



Split-second response helps keep

CONTROL AND INTERCEPT VALVES, located close to the point of steam admission, reduce the amount of high-energy steam entrained downstream from the closed valves—steam that could cause excessive acceleration and resultant tripout.





General Electric turbines on-the-line

SENSITIVE GOVERNING SYSTEM COPES WITH TEMPORARY SYSTEM DISTURBANCES

Requirements for sensitive, faster-responding governing systems have steadily increased with the trend toward larger reheat turbines with their inherent high overspeed potential.

Modern turbines entrain significant quantities of high-energy steam downstream from control and intercept valves and in crossover pipes. Because this steam can cause rapid acceleration upon load loss, governing systems must instantly sense speed changes to ride through temporary system disturbances. A split-second time lag may mean the difference between tripout and continued turbine availability.

Locating control and intercept valves as close as possible to the turbine operating stages reduces the amount of high-energy steam trapped downstream from the valves. With the acceleration potential of this entrained steam kept to a minimum, overspeed is limited and the turbine remains on governor control despite temporary system interruptions.

Other refinements such as use of an extremely sensitive governor and relays help make fast response possible. This governor senses the slightest change in speed and transmits a signal to activate the governing system.

Sensitive response of governing systems is another example of how General Electric turbine research and engineering leadership combine to build tomorrow's turbine-generators today. For further information on reheat turbine overspeed protection, write for bulletin GER-920, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, New York. 254-39

Progress Is Our Most Important Product

GENERAL ELECTRIC

Now Under Construction...

18% MORE POWER

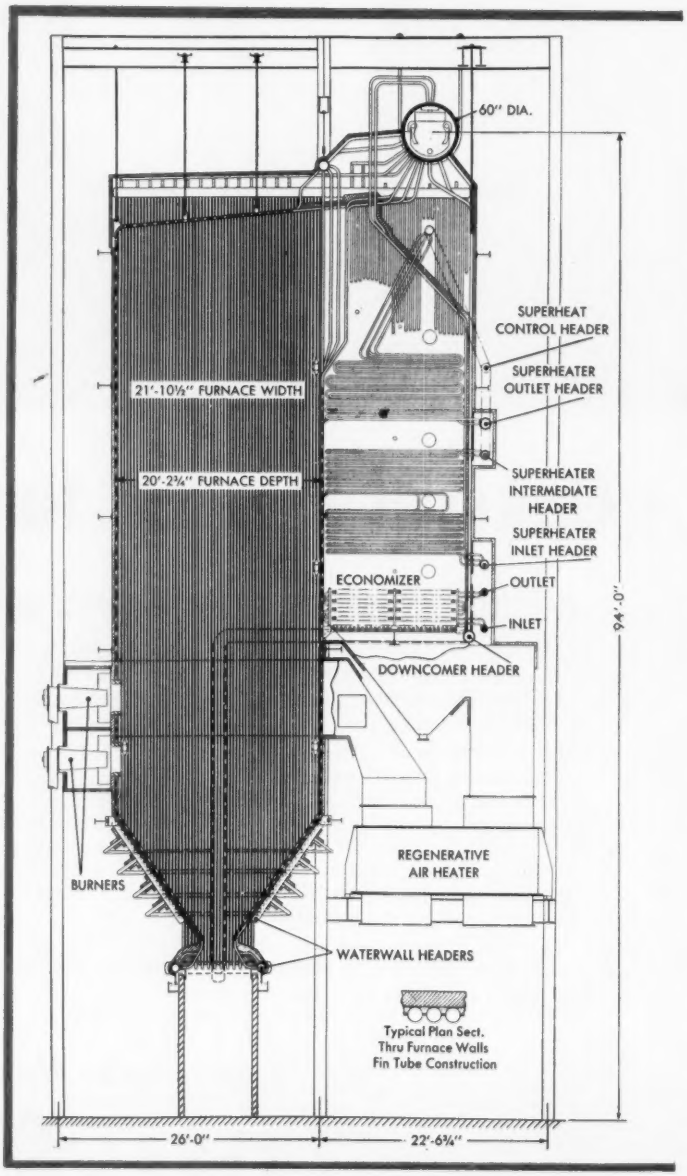
New 88,000-kw Yarmouth Station
will be served by

TWO FW STEAM GENERATORS

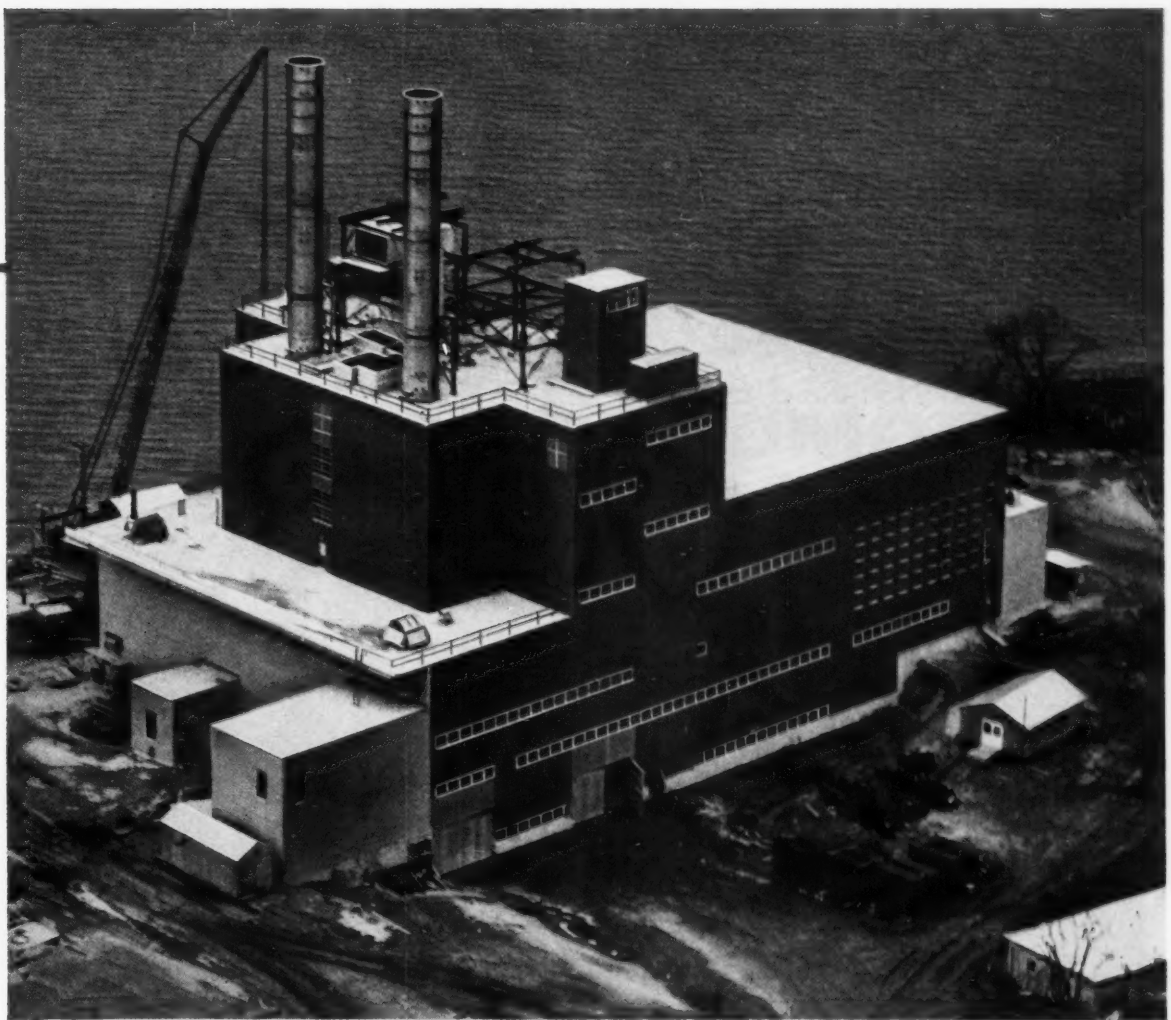
To meet Maine's growing demand for electric power, the Central Maine Power Company is building a new station at Yarmouth which increases total system capacity from 470,730 to 558,730 kw. This installation will consist of two identical units, each with a rated capacity of 44,000 and capability of 50,000 kilowatts.

Foster Wheeler is supplying the two steam generators for this important new station. Each will produce 490,000 pounds of steam per hour at 1575 psig design pressure, 950 F, and will deliver steam to the turbines at 1250 psig. These units are designed for either oil or coal firing.

With more than fifty years of experience in steam generation—and the finest modern manufacturing facilities in three large plants — Foster Wheeler welcomes the opportunity to quote on your requirements. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*



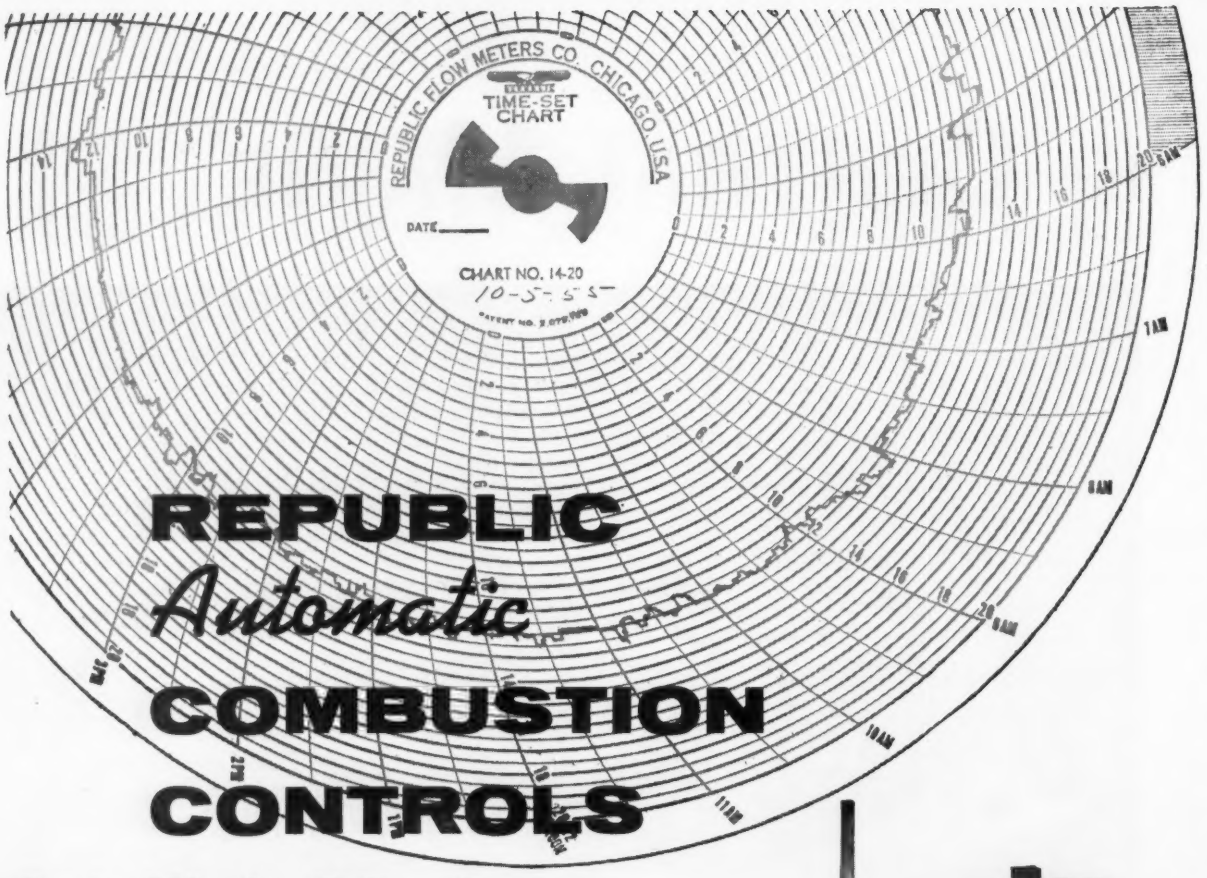
for CENTRAL MAINE



An aerial view of the new Yarmouth Station of Central Maine Power Company. Unit No. 1 is scheduled to be in operation this year and Unit No. 2, in 1958. During the past decade, virtually every kind of Maine business has drastically increased its kilowatt-hour use of electric power. The Yarmouth Station will keep CMP well ahead of this growing demand — immediately increasing total system capacity by 18%.

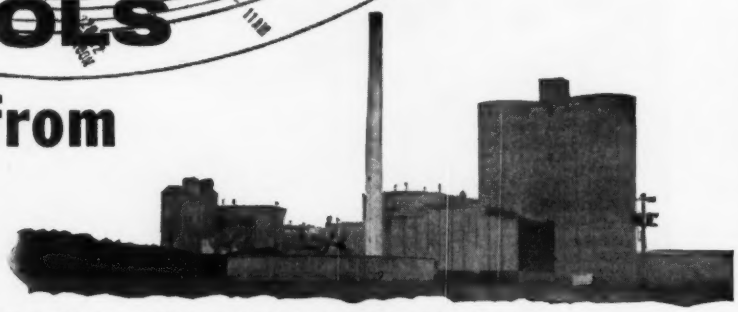
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.



REPUBLIC *Automatic* COMBUSTION CONTROLS

Get High CO_2 from Low Grade Coal



at UTAH-IDAHO SUGAR COMPANY'S NEW $7,000,000 PLANT

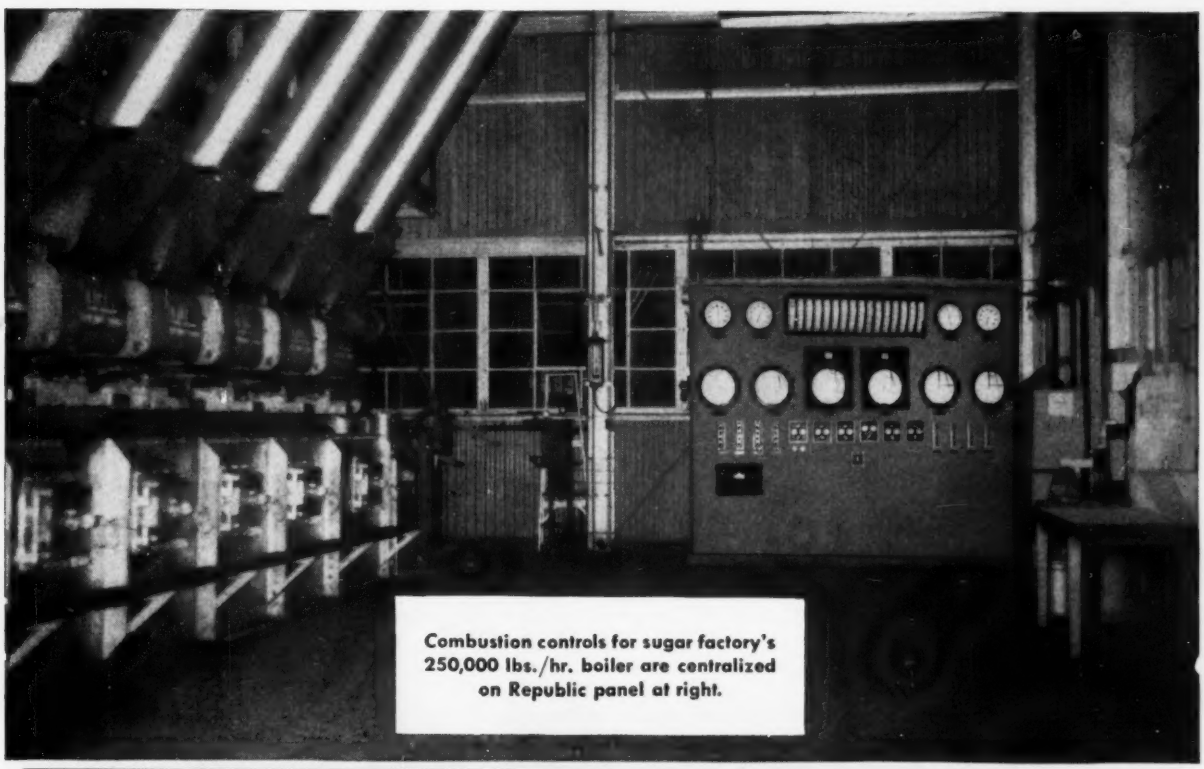
In any power plant, the percentage of CO_2 in combustion gases is indicative of combustion efficiency. But at the power plant for Utah-Idaho Sugar Company's new sugar beet factory, Moses Lake, Washington, a good CO_2 performance record is more than desirable. It's actually essential! That's because the plant supplies not only steam, but CO_2 as well to sugar-making processes. The CO_2 is extracted from combustion gases and becomes a vital ingredient in the production of over 75,000,000 lbs. of sugar and thousands of tons of molasses the factory produces annually. With the plant limited to low grade western coal, continuous maximum combustion efficiency at all loads is necessary to insure adequate CO_2 for processes.

Republic Automatic Combustion Controls enable the plant's spread stoker fired 250,000 lbs./hr. boiler

operating at 400 psig and 575°F. to meet CO_2 requirements while matching steam supply to process demands. Daily CO_2 charts indicate the boiler is consistently producing 12–13% CO_2 in spite of the quality of coal burned.

According to operators, ash removal, cleaning of the fire and soot blowing can be carried out with the combustion controls on automatic without disturbing the fuel-air ratio. Furnace draft is controlled satisfactorily despite the high stack on the plant. Turbine drives on forced and induced draft fans are speed controlled by the combustion controls, eliminating the need for dampers. A three element Republic boiler feedwater system is also tied in with the combustion control system to automatically supply the proper amount of water to the boiler at all steaming rates.

This plant is one more example of how Republic combustion engineers design control systems that enable boilers to exactly meet individual plant requirements. There are Republic Combustion Controls for any size or type of boiler, for all methods of fuel firing, all arrangements of draft and all load conditions. When you want to be sure of getting maximum boiler performance, ask Republic to design and build your combustion control system.

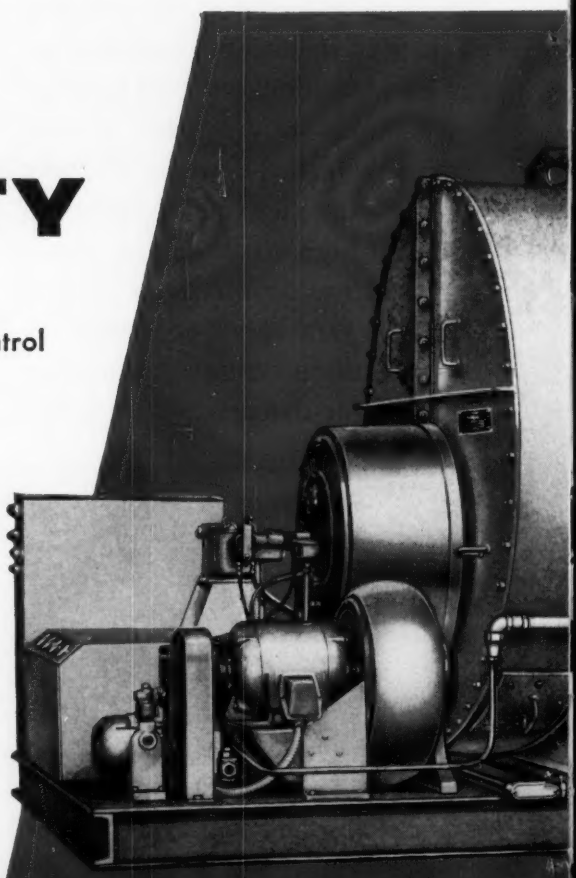


Combustion controls for sugar factory's 250,000 lbs./hr. boiler are centralized on Republic panel at right.

REPUBLIC FLOW METERS CO.
A Subsidiary of Rockwell Manufacturing Company
2240 Diversey Parkway • Chicago 47, Illinois

1 Package 1 Shipment

That's FT by ERIE CITY

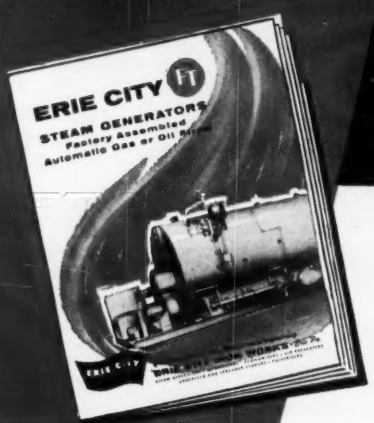


● A truly modern conception of the boiler-burner-control package fire tube steam generator. Manufactured, assembled, wired, piped, and factory fire tested—ready to go to work when it reaches your plant.

Behind this Erie City package unit is the manufacturing skill and engineering know-how acquired through more than a century of producing large, high pressure, water tube and fire tube industrial power boilers.

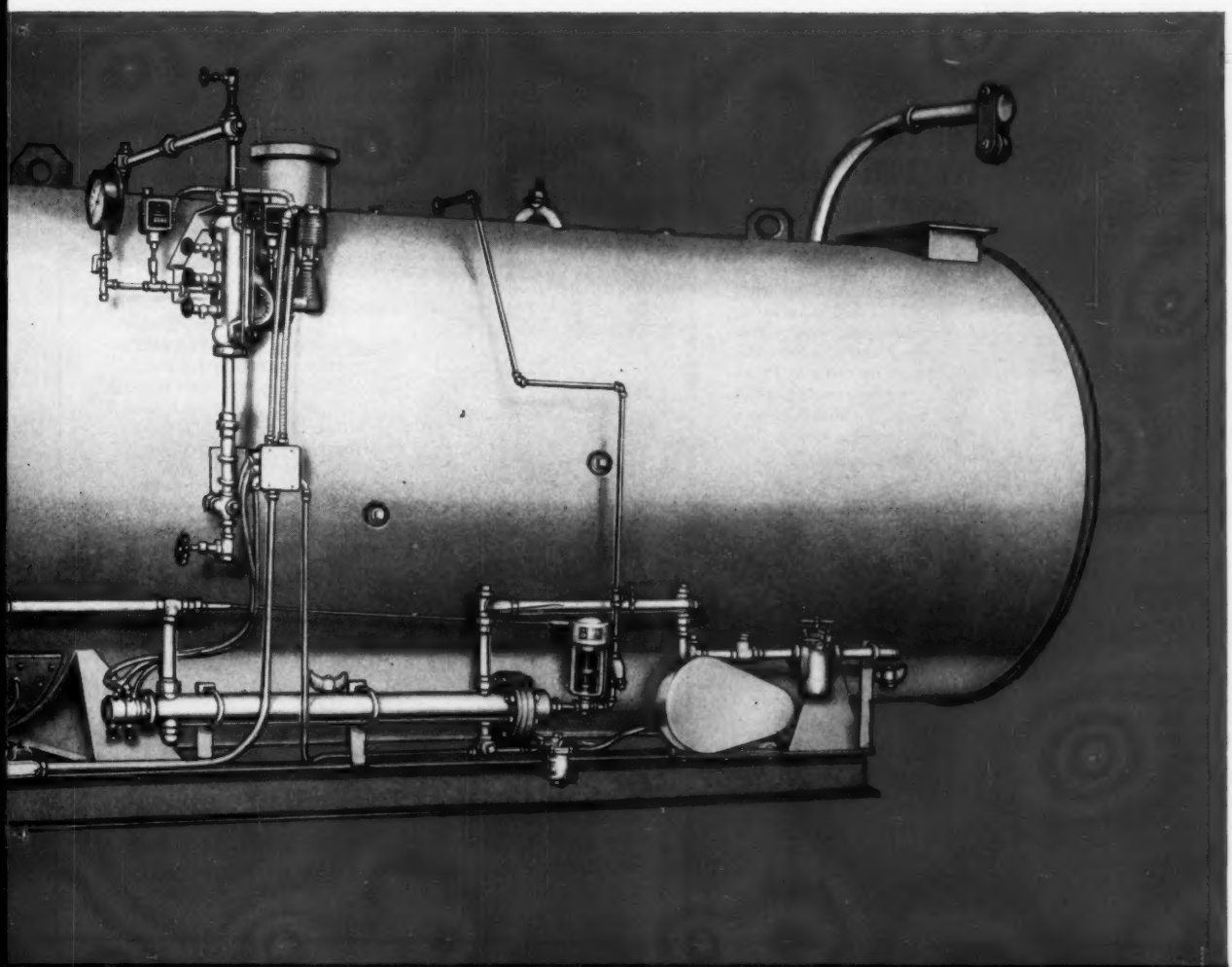
The FT is conservatively designed, having five full square feet of heating surface per developed horsepower. Peak ratings are easily attainable with no undue strain on the boiler and its attendant high maintenance costs.

For a complete description of the FT write for Bulletin SB-562G.



You

1 Responsibility



can depend on Erie City for sound engineering . . .

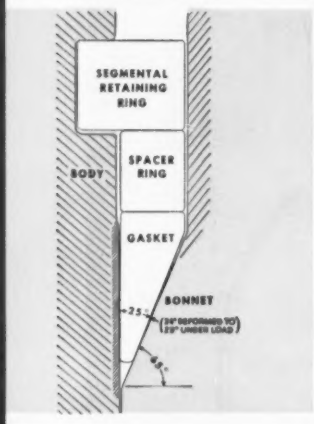
ERIE CITY
117 Years in Steam Generation

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

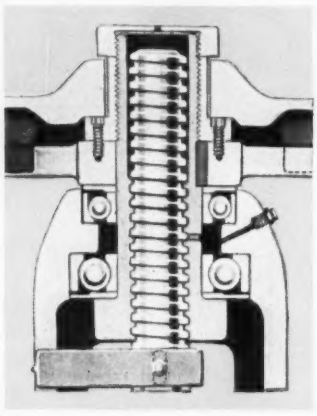
How To Get SPECIAL Features

Tips on selection, installation and operation of steel



NON-LEAK PRESSURE-SEAL BONNET JOINT

By changing bonnet-gasket angle from 45 degrees to shape shown, sealing area is increased 300%, sealing force doubled. Soft iron gasket is electroplated with a lead alloy which flows under pressure, assures tight seal. No sharp gasket edge to damage. Easily disassembled.

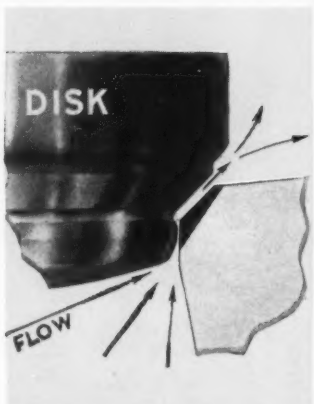


EVALTHRUST* BALL-BEARING CONSTRUCTION

This patented ball-bearing construction is found in all large, high-pressure Edward Valves. Double races on the yoke stem reduce operating torque . . . effectively transmit highest closing torques. An Edward "exclusive."

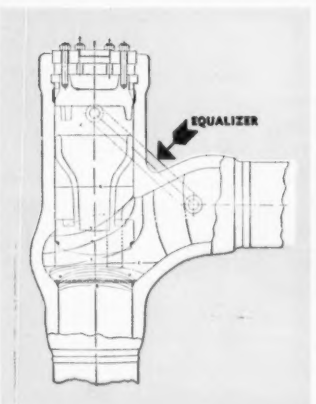
LEAK-PROOF INTEGRAL SEAT

Integral Stellite seat in Edward Valves cuts maintenance, prevents leakage between seat and body. For perfect alignment, applied Stellite is precision-machined in same set-up as body bore, then carefully lapped to form drop-tight mated seating surfaces.



ORIGINAL-DESIGN EDWARD EQUALIZER

For check and non-return valves, the Edward Equalizer connects the high-pressure area above disk-piston with the high-velocity, low-pressure area in the valve outlet. Increases disk lift, cuts pressure drop, reduces disk vibration.



EVALPAK* PREMIUM VALVE PACKING

Edward developed the *first* asbestos-graphite packing with special processing to prevent stem pitting. Die-molded to fit exactly the stem and stuffing box, it is wire-supported and features low operating torque. Durable, easily replaceable.

IMPACTOR* HANDWHEEL

Exclusive Impactor* handwheel multiplies the closing force a man can deliver, assures tight seating with minimum effort in minimum space. Often eliminates need for bulky, expensive gearing or motors.

*Reg. T.M., Edward Valves, Inc.

Rockwell-Built Edward Valves

in STANDARD *Steel Valves*

valves from Edward, long-time leader in the field

We all know that no one gets "something for nothing." Yet, by careful evaluation and selection, it *is* possible to obtain "special" features in *standard* steel valves. The secret lies in buying "by company" as well as by price. In dealing with Edward, whose products have been the industry's standard of excellence for years, you avail yourself of three important benefits:

1. access to the results of continuing laboratory research on steel valves;

2. expert assistance on valve selection, installation, operation, maintenance and repair;

3. steel valves which are truly superior in design, function and durability . . . but which are not substantially more expensive than ordinary types.

For example . . . a half-dozen "special valve" features —which are *standard* in Edward Valves—are shown in handy clip-out form on the opposite page. ALL of these features are Edward "firsts" . . . MOST are Edward "exclusives" . . . EACH means *extra value* for you!

We invite you to consult your Edward Valve Representative. He is technically trained, thoroughly experienced, eager to help you obtain the *most* value for your valve dollar. At his disposal—and yours—are the results of substantial investment in steel valve research. Let him *use* those results to solve your problems. A card or a call will bring him "on the double" . . . so make it a point to contact us *now!*

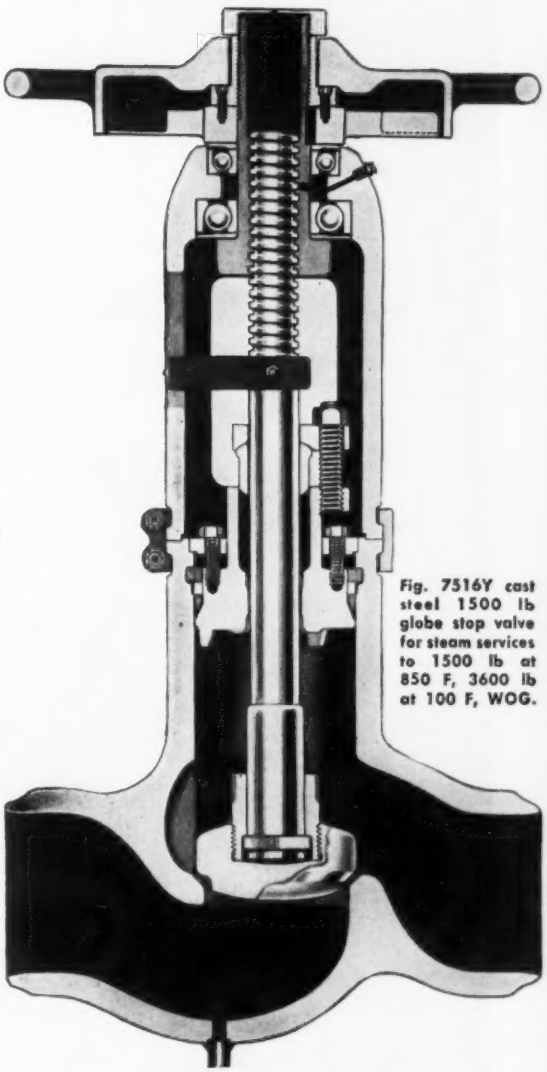


Fig. 7516Y cast steel 1500 lb globe stop valve for steam services to 1500 lb at 850 F, 3600 lb at 100 F, WOG.

Edward builds a complete line of forged and cast steel valves from ⅛" to 16" in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs for pressures up to 7500 lb with pressure-seal, bolted, union or welded bonnets and screwed, welding, or flanged ends.

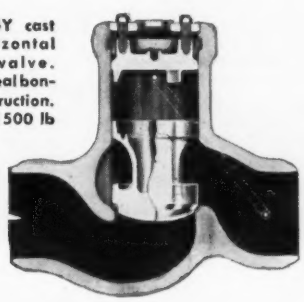


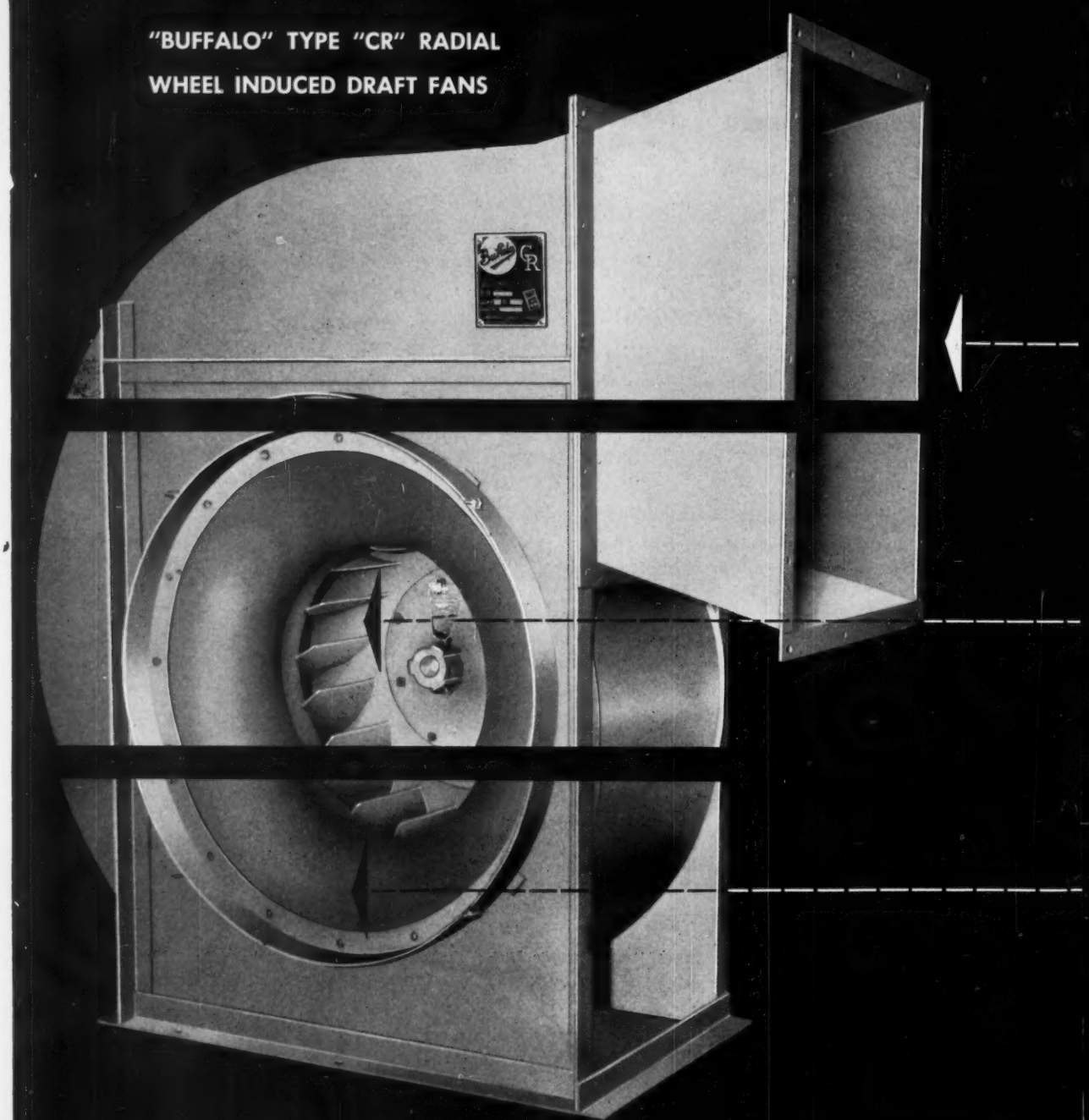
Fig. 7594Y cast steel horizontal check valve. Pressure-seal bonnet construction. Rated at 1500 lb at 850 F.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, EAST CHICAGO, INDIANA

"BUFFALO" TYPE "CR" RADIAL WHEEL INDUCED DRAFT FANS



Radial Wheel Fans are just one of a complete series of "Buffalo" Draft Fans covering the full range of varying boiler requirements. Whether you are interested in extremely high efficiency — fan size or first cost, "Buffalo" can offer you the best selection — with no compromise. Contact the "Buffalo" Engineering Representative nearest you, or write us about your requirements today!

ARE THESE THE FAN CHARACTERISTICS TO MEET YOUR INDUCED DRAFT REQUIREMENTS?

● **DIVERGENT OUTLET IMPROVES STATIC CONVERSION** — Providing a gradual change from velocity at the fan cutoff to static pressure in the duct, this unique "Buffalo" feature eliminates a common source of turbulence in fans. From inlet to outlet, such complete streamlining has produced a new high in efficiency. At the same time, it has minimized abrasive effects in every part of the fan.

● **3 WHEELS TO CHOOSE FROM** for varying characteristics within the "Buffalo" Radial blade type of fan. Besides the type "CR", two other types may be selected for different volume and pressure characteristics. Note the deeply pressed curved flange for smooth air flow and rigidity. The blades are radial at the tip, curving smoothly forward at the inlet.

● **SMOOTH CURVED INLET PATH** formed by inlet bell and matching wheel flange minimizes both turbulence and abrasive effect. The "CR" is the only fan of its kind designed for either open inlet or variable inlet vanes — and is therefore an excellent choice for inlet volume control. "Buffalo" cantilevered inlet vanes do not reduce the high performance of this fan.

● **HIGH VOLUME, HIGH PRESSURE** — This characteristic of the "Buffalo" Type "CR" Fan not only makes it desirable for many induced draft applications — but often makes possible selection of a smaller size on certain direct drive installations, for lower first cost.

● **RESISTANCE TO ABRASION** — This has made the "CR" popular on coal-fired boilers and other abrasive jobs. Available with wearing strips for the most severe conditions, though complete streamlining makes it inherently resistant to abrasion.

● **OVER 78% MECHANICAL EFFICIENCY OVER A WIDE RANGE** — a very favorable balance of performance with low first cost and low operating cost. (Where efficiency is the principal consideration, your choice might be a "Buffalo" Airfoil or Backward Curve Fan.)

● **LONG LIFE UNDER SEVERE SERVICE** — In addition to inherent resistance to abrasion, the "CR" has the typically heavy-duty, rigid construction of all "Buffalo" Draft Fans — heavy plate housing and blades, oversize shafts and bearings.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life in every "Buffalo" product.*

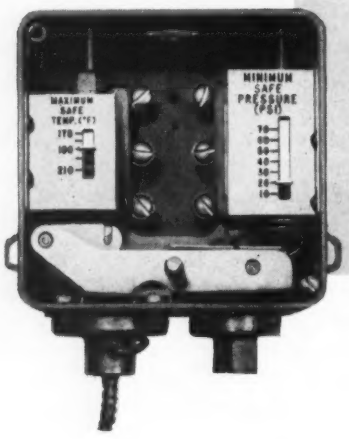
BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Temperature and pressure set points are inside the case, protected against accidental manipulation. Cover is removed for easy adjustment.



New Diesel engine safety switch

...gives fail-safe protection

This all-new Honeywell safety switch responds to abnormal pressure or temperature to stop or idle a diesel engine, or actuate an alarm circuit.

It combines separate systems for measuring engine coolant temperature and lubricating oil pressure. The temperature system includes an exclusive fail-safe feature, so that in case of damage to its temperature bulb, capillary or diaphragm, the switch responds as it would to excessive temperature.

Temperature and pressure settings can't drift off set points. There can be no false shutdowns due to vibration. Set points are easily adjustable in the field.

Your nearby Honeywell sales engineer will be glad to give you complete information about the new Diesel Engine Safety Switch. Call him today . . . he's near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pennsylvania—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Specification sheet S1010-5 "Diesel Engine Safety Switch."

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

THE ANCHOR PACKING COMPANY

OFFERS

PLASTIC PACKINGS FOR MANY USES!

CARBONITE...COIL

INDUSTRY finds many uses for Style 808-C Cotton Jacket plastic Anchor packing, including centrifugal pump shafts, high or low speed; rotary rods or shafts; reciprocating rods and plungers; expansion joints; valve stems, and other applications against air, oil or water. It is unique in that it contains no wax or tar.

CARBONITE 808W (Ring and Spiral)

FOR FOOD PROCESSING APPARATUS, there is no better packing than this Anchor product. Style 808-W is a white mixture in which powdered mica has been substituted for flake graphite, making it suitable where graphite might be objectionable.

STYLE 8806-N.J. (No jacket) Ring, Spiral, is another flexible packing in which Anchor uses pure asbestos fiber and mica lubrication for food handling devices where graphite is not desired.

CARBONITE ANGULAR MOLDED RING

STYLE 808-Q is extensively used where conditions range as high as 1650 pounds of steam and temperatures run as high as 950° F. Meets exacting needs of turbine control valves, expansion joints, header valves and all high temperature, high pressure packing requirements.

These are but a few of the many Anchor Plastic Packings. For complete information we invite you to write today.

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GENERAL OFFICES: PHILADELPHIA, PA.

FACTORIES: MANHEIM, PA. ELKHART, IND. MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

now fully

YARWAY REMOTE BOILER

With the addition of the new pressure compensator described on opposite page, full-scale accuracy of water level indication is provided not only at "working pressure" but *also at all other boiler pressures.*

The Yarway Remote Indicator now offers *completely accurate readings of the boiler water level under every operating condition.*

For complete information on Yarway Indicators and pressure-temperature compensation, write for Bulletin WG-1814 and new compensator supplement.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NOTE: Ask about the application of Yarway Indicators for 900 psi and higher pressures under Boiler Code Case 1155 (two indicators in place of one of the two required gage glasses).

YARWAY

...a good way

compensated
WATER LEVEL INDICATORS

ADVANTAGES OF YARWAY PRESSURE COMPENSATOR

1. Compensating mechanism is applied to the Yarway indicator without change in internal construction of the indicator.

2. Well-known dependability of bourdon tube insures reliability and long life.

3. Trouble-free operation because linkage is simple and direct.

4. For maximum sensitivity, the indicator pointer is mounted on jewel bearings.

5. Rugged shock-resistant mounting carries weight of compensator mechanism without burdening the pointer mechanism.

6. Boiler conditions are readily simulated for check of instrument calibration at operating pressures, with remainder of indicator system under atmospheric pressure.

7. Application of pressure-temperature compensation for density changes in boiler water insures desired accuracy of level indication at all operating pressures and at all points on the pointer scale.

Model showing mechanism of Yarway Pressure Compensator. Placed between indicator operating and indicating elements, the compensator mechanism corrects the level indication by changing pointer travel to compensate for variation in water density due to changes in boiler pressure.

(Not shown) Yarway Remote Hi-Lo Alarm Signals (lights and/or horns), operated by the Indicator. May be placed at any location in the plant.

(Not shown) Yarway Electronic Secondary Indicator to provide duplicate reading at any other location. Same size and appearance as primary indicator.

to specify remote liquid level indicators

You'll never have to nurse this O_2 Analyzer

What are your most serious complaints about O_2 analyzers? Cumbersome? Slow? Unstable? Hard to service on the job?

You won't find these potential trouble-sources in our new Unitized O_2 Gas Analyzer. They've been literally "designed out" by L&N engineers with experience totaling millions of man-hours in industrial gas analysis.

The Unitized O_2 Analyzer is reduced to the essentials consistent with highly efficient O_2 measurement and control. The entire analysis is made within the 2-component team of O_2 Analyzer Assembly and Speedomax® recorder, eliminating unwieldy auxiliary components such as sample conditioners. Due to its direct magnetic operation, the equipment employs neither auxiliary gas supplies, chemical reactions, nor combustion. Sample and calibration controls are accessible externally, without disturbing the measuring system.

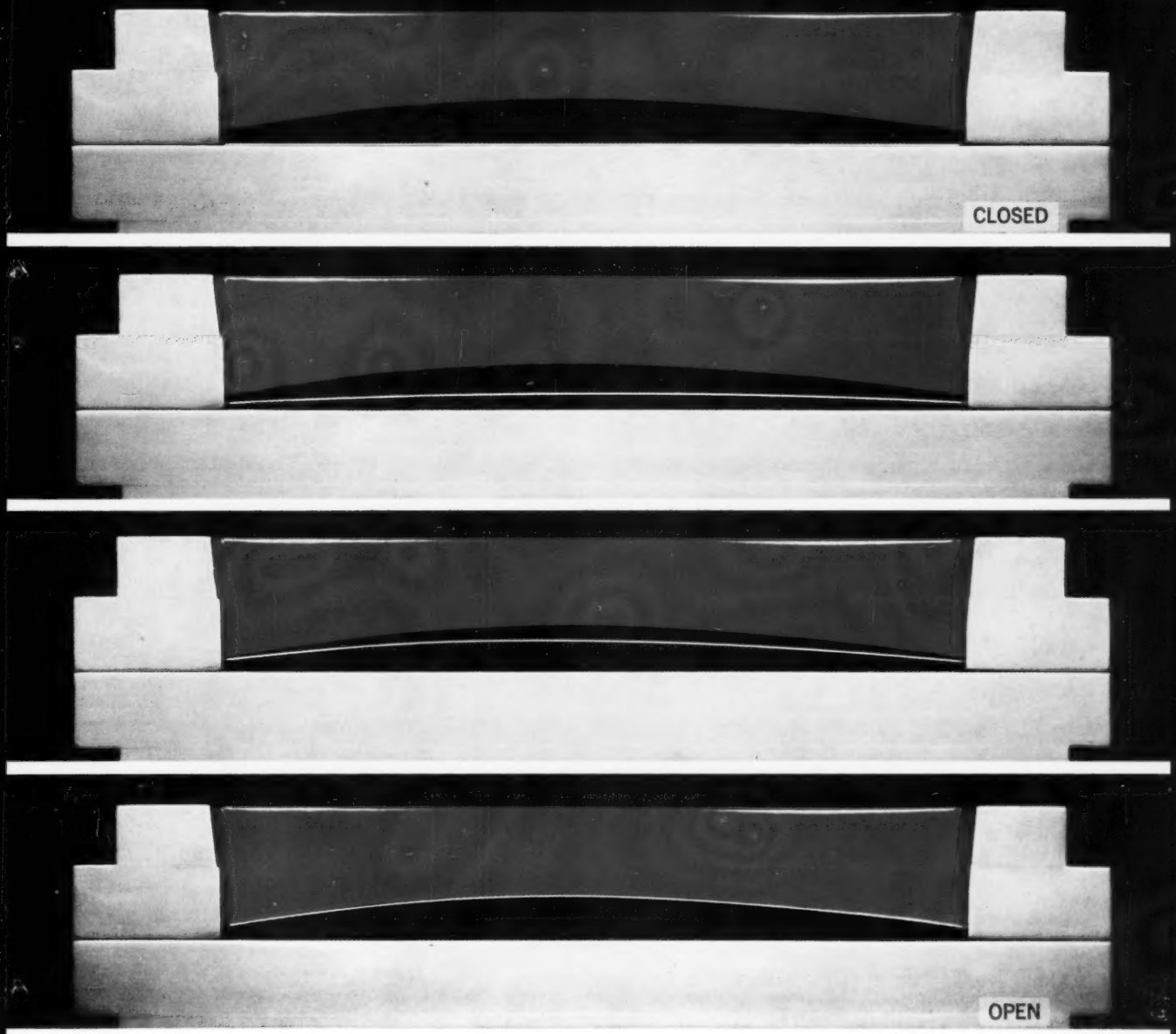
We've introduced sampling innovations, too. The Analyzer gets a sample not only cleaned but purified. A typical sampling lag is 1 sec per 45 ft of ¼" tubing, up to several hundred feet.

The Unitized O_2 Analyzer can help to streamline O_2-dependent processes. For pertinent details of this O_2 monitor, write to Stenton Ave., Phila. 44, Pa., for Folder ND46-91(5).

PERFORMANCE

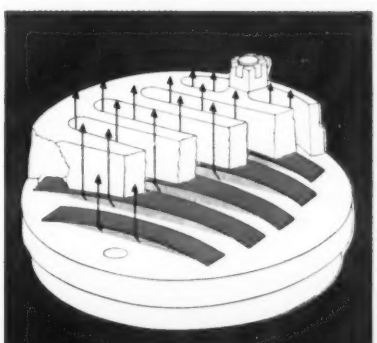
Range	*0 to 5% O_2, 0 to 10% O_2, or higher in flue gas or N_2 as specified.*
Accuracy	*0.15% O_2*
Sensitivity	*Better than ±0.05% O_2*
Stability	*Better than ±0.15% O_2*
Response	*4 sec for initial response; 40 sec for 90% response.*

LEEDS instruments **NORTHRUP** automatic controls • furnaces



Key to Compressor Reliability . . .

WORLD'S SIMPLEST COMPRESSOR VALVE!



Stainless steel strips, in red, open the Feather Valve ports by rolling contact against the lower plate. There is no impact.

The Feather Valve* is the only compressor valve with no buffer plates or cushioning accessories. The strip is the only moving part and the valve itself is all but indestructible. The fastest-acting on the market, Feather Valves are standard equipment on all Worthington compressors.

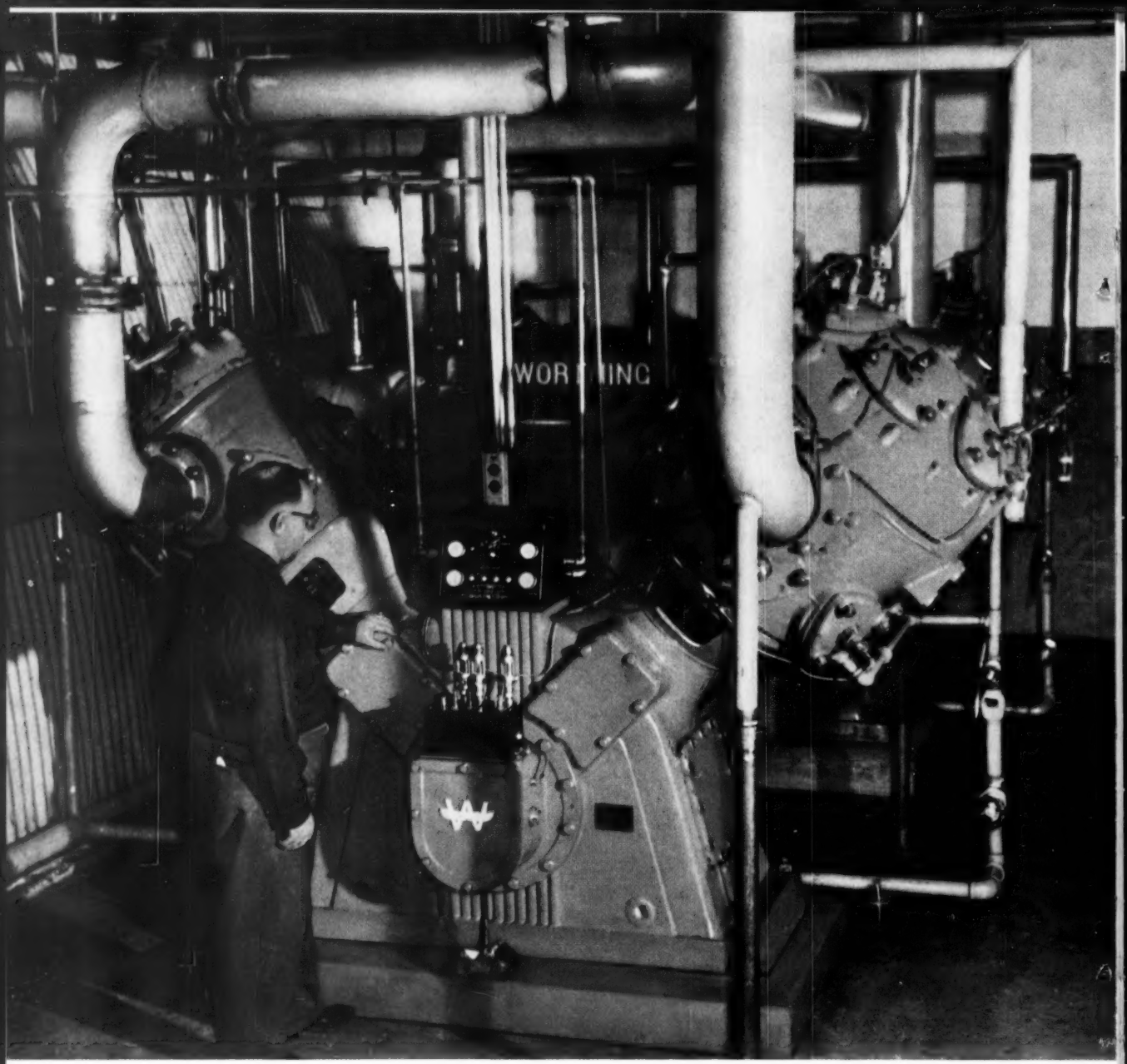
Their extremely fast action means you get virtually no slip or backflow. As a result Worthington compressors give you minimum valve loss and use minimum power.

No Impact. Combined with fast action is Worthington's exclusive "no impact" operation which assures long life and negligible maintenance. The flexible strips open and close with a gentle rolling contact.

For a first hand story of a Feather Valve's ruggedness, see the next page.

WORTHINGTON

*Reg. U. S. Pat. Off.



Feather Valve compressors at Twin Coach plant...

IMPROVE AIR SUPPLY, CUT MAINTENANCE

"This compressor installation cut maintenance costs and improved reliability," reports John Anthony, Twin Coach Company, Aircraft Division plant in Buffalo, New York. "We centralized our compressed air supply with installation of three heavy duty, water-cooled, 2-stage 100 psi Worthington Feather Valve compressors."

Constant-pressure, reliable air supply is the basic Twin Coach manufacturing power service. Regular scheduled preventive maintenance inspections (only four times per year) show that these compressors are giving entirely satisfactory performance.

Valves are your key to compressor reliability. Feather Valves, interchangeable between compressor suction and inlet, are the surest acting, tightest, most flexible and fastest made. They are most reliable because they are simplest.

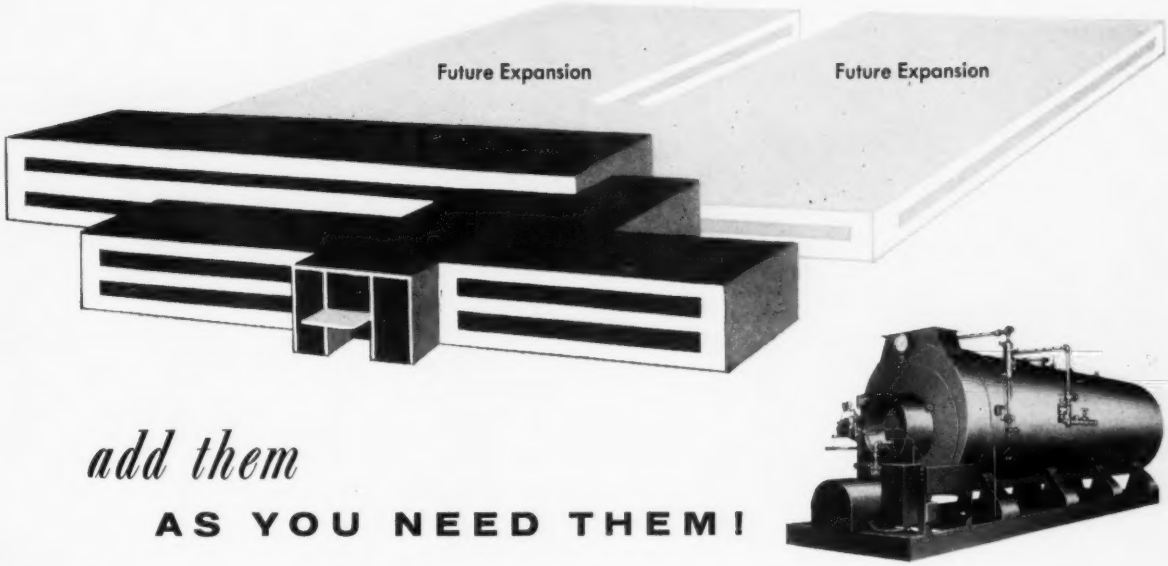
For information regarding your compressed air needs, contact Worthington Corporation, Section K-72, Harrison, New Jersey, stating requirements—or contact your local Worthington representative located in every major city.

WORTHINGTON

See preceding page

Plan for tomorrow

with CYCLOTHERM today!



add them

AS YOU NEED THEM!

With Cyclotherm Steam and Hot Water Generators you can plan your steam generating facilities to cover five — ten — fifteen years of plant expansion. Perhaps one 500 HP Cyclotherm will meet your present requirements. If you need 600 HP in 1958 — add a 100 HP Cyclotherm. If 200 more HP is needed in 1959, a 200 HP Cyclotherm will give you ample — *but not excess* — capacity. You buy as you grow — you pay only for what you use.

Only Cyclotherms lend themselves perfectly to a *progressive* increase in steam capacity. You can get them in 17 sizes — add units ranging from 18 to 750 HP. They're installed easily — need no stack, no excavation, no special foundation. A battery of Cyclotherms is easy to accommodate — a Cyclotherm takes up to 1/3 less space than even other package boilers. Completely factory assembled, too — set one down and with five simple connections it's ready to work.

Cyclotherm's Cyclonic Combustion guarantees plus 80% efficiency in only two passes. Larger units operate at from 30% to 100% of rated capacity without loss of efficiency — smaller units operate on and off automatically as load requires. Maintenance costs drop from 30% to 50%. And Cyclotherm's world-wide service-facilities are always at your disposal. For full information, write us today.

Swan Rubber Did It — So Can You!

Swan Rubber Co., of Bucyrus, Ohio, world's largest maker of garden hose, installed an 80 HP Cyclotherm in 1949. As Swan expanded, it installed:

1951	100 HP Cyclotherm
1953	100 HP Cyclotherm
1954	125 HP Cyclotherm
1955	125 HP Cyclotherm
1956	Two 500 HP Cyclotherms, one 125 HP Cyclotherm. (Built additional plant in 1956)

And Swan plans to install during 1957 another 500 HP, another 125 HP and a 30 HP Cyclotherm. In 1949, Swan planned for the future with Cyclotherm. You can plan for your future with Cyclotherm today.

YEARS AHEAD
IN STEAM
GENERATION
CYCLOTHERM®
STEAM AND HOT WATER GENERATORS

A Division of National-U.S. Radiator Corp., Oswego, N.Y.

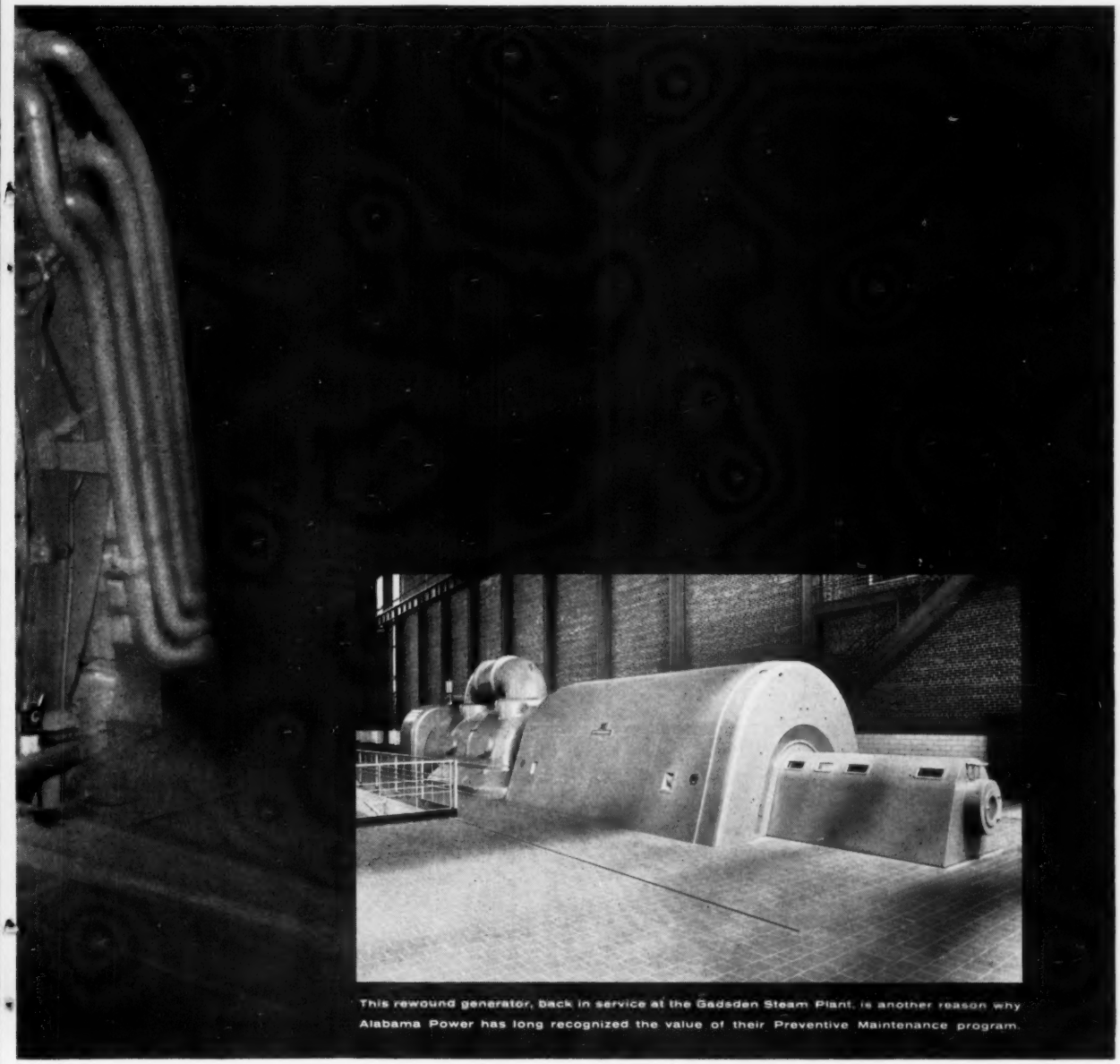
Clip to Your Letterhead:

Cyclotherm Division
National-U.S. Radiator Corp.
25 E. First St., Oswego, N. Y.

Please send me your booklet *Cyclotherm Cyclonic Combustion*, also rotogravure copy of *Cyclotherm Sales Steam* with illustrations and descriptions of Cyclotherm installations.

Westinghouse Preventive Maintenance at Alabama Power Company

FROM COIL ORDER TO COMPLETED REWIND IN 4 WEEKS



This rewound generator, back in service at the Gadsden Steam Plant, is another reason why Alabama Power has long recognized the value of their Preventive Maintenance program.

Westinghouse Preventive Maintenance Inspection Service serves Alabama Power Company, again. When Westinghouse field engineers inspected this 60,000-kw generator in February, 1957, during scheduled overhaul of the generating unit, they found conditions which led to a decision to rewind it during the outage then in progress. Westinghouse was ready with men and materials to do the job.

Alabama Power stated the unit couldn't be out of service for more than 5 weeks, or they would suffer additional loss. Westinghouse alerted its personnel, ordered the coils and started working 20 hours a day, 6 days a week, to strip and rewind. The job was completed March 14th, 28 days after the customer order was given.

Skilled, highly trained Westinghouse field personnel will perform preventive maintenance inspection, on-the-spot repairs and modernization to keep your electric apparatus operating at peak efficiency. Nationwide, they are on call 24 hours a day with fast, reliable service.

Contact your Westinghouse salesman, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. J-95183

YOU CAN BE SURE...IF IT'S Westinghouse

for every temperature range—
for every operating condition

Carey®

SERVICE-PROVED INSULATIONS

Service Report on Carey Insulations at:

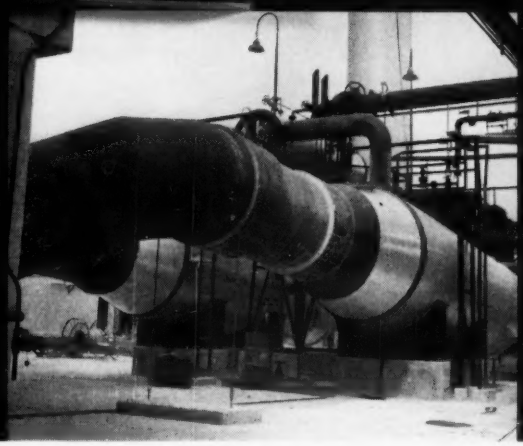
TEXAS BUTADIENE & CHEMICAL CORPORATION

Channelview, Texas

GENERAL CONTRACTOR: The Fluor Corp., Ltd.
INSULATION CONTRACTOR: B&B Engineering & Supply Co.

The Texas Butadiene chemical plant is the first completely new butadiene facility built since World War II. It is entirely an outdoor installation. Excepting turbines, all equipment (including 75 miles of piping) is exposed to the weather. Normal plant operation requires 30,000,000 cu. ft. of gas per day, with a heating value of 850 BTU per cubic foot. The company's primary products are butadiene, used in making synthetic rubber, and high octane aviation gas.

Carey® alltemp saves construction



5" thick Alltemp helps conserve heat used to make steam from these two waste-heat boilers. Operating temperature: 1150°F.

This horizontal hydrocarbon drum is insulated with a 2" thickness of Carey Alltemp. Operating temperature is approximately 400°F.

time and inventory costs at new Texas plant

The climate is mild in Channelview, Texas. Temperatures seldom dip below freezing (5 days per year on the average)—and during much of the year extremely high humidity brings continual rain. These were the conditions that Texas Butadiene faced when construction started on the company's new "open air" chemical plant. In February 1957 the plant began operation, with Carey Alltemp as the basic insulating material for all piping and equipment over 400°F. Here's what Texas Butadiene's Chief Engineer, T. H. Pierson, had to say about Alltemp's performance during the 18 month construction period:

"Carey Alltemp does not readily absorb water or moisture. Wherever possible, Alltemp was used in combination with Carey Weatherproof Jacketing. This assured us of a minimum delay in construction time, in the event of recurring rains. Workers were able to begin applying more insulation as soon as the rain stopped."

Reductions in plant maintenance inventories and storage requirements were other factors that influenced Alltemp's selection, according to Mr. Pierson. "Since Alltemp can be used for all temperatures from ambient to 1600°F., the necessity of stocking two different kinds of material to cover medium and high temperature applications was eliminated. Now, one insulation does both jobs—saves us storage space and inventory costs.

"And Alltemp is a relatively clean material to work," Mr. Pierson added. "It's unusually tough, too, for a molded, high temperature insulation. These two properties cut construction time still further by reducing the number of hours spent in cleaning up the work site."

With Texas Butadiene's new plant in full operation, Carey Alltemp is now performing its most important service—helping produce the steam that drives the plant's power equipment. And Alltemp is performing this service under what may well be the country's toughest moisture conditions, and at operating temperatures that often exceed 1100°F. Truly another success story for *industry's only all-purpose insulation!*

◀ Part of the plant's 75 miles of piping can be seen in this view of the pipe rack. Temperatures in the various lines range from 150° to 750°F. Pipe covering is Carey Thermoglas (up to 350°F.) and Alltemp (350°–750°F.).

Better Products for Industry Since 1873

THE PHILIP CAREY MFG. COMPANY

Lockland, Cincinnati 15, Ohio

The physical characteristics of Carey insulation products are measured and tested with scientific precision by Mellon Institute of Industrial Research, Pittsburgh, Pa. This is your assurance of the accuracy of Carey product specifications. Mail coupon for literature and sample specifications, or write for the name of your Carey Industrial Sales Engineer.

THE PHILIP CAREY MFG. COMPANY, Dept. P-77
Lockland, Cincinnati 15, Ohio

Please send literature and sample specifications on

☐ Alltemp ☐ Thermoglas

☐ Please have your Industrial Sales Engineer call.

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STEPHENS-

the big name in

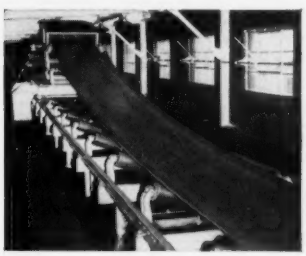
-ADAMSON

coal conveying systems for power

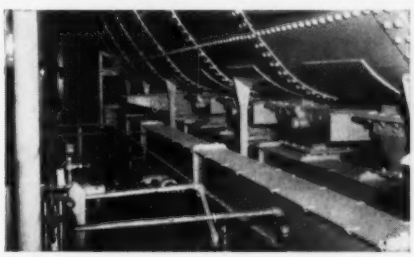
To squeeze every last kilowatt from every ton of coal consumed, power producers know the conveying system must be right. It means a system properly engineered to the specific need with low initial installation cost. It means one that requires minimum maintenance and operational manpower for years to come.

S-A engineer strategists have been planning and building such conveying systems for over fifty years. At this very moment, many of them are helping to provide cheap power in hundreds of private and utility power plants all over the world.

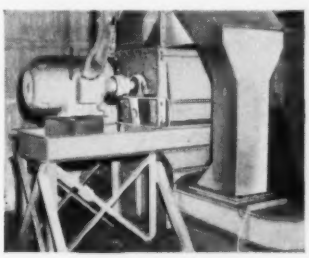
Stephens-Adamson sales engineers, backed by the most complete line of manufactured equipment, blanket all important industrial areas. They can show you why it pays to convey with S-A.



An S-A belt conveyor brings coal into a mid-west power plant. A belt tripper deposits the fuel into bunkers through traveling tripper spouts.



S-A Redler conveyors provide dust-tight coal movement from storage bunkers. Redler designs permit easy coal movement over horizontal, vertical, or inclined planes.



An institutional power plant employs S-A Knittel crusher to reduce coal lump size. It will handle damp coal without plugging or decrease in capacity.

S-A manufactures a wide range of material handling products in three complete plants in U. S. and Canada.

- Belt Conveyors
- Belt, Pan & Plate Feeders
- Ship Loading Boom Conveyors
- Stacking Conveyors
- Storage & Reclaiming Systems
- "Natural Frequency" Vibrating Conveyors
- REDLER Conveyor-Elevators
- ZIPPER Conveyor-Elevators
- Conveyor Belt Cleaners
- Headshaft Holdbacks
- Grizzlies & Screens
- Centrifugal Pilers
- Bin Gates & Tunnel Gates
- Car Pullers & Spotters
- Bucket Elevators
- Skip Hoists
- SEALMASTER Ball Bearing Units

• *Write for a bulletin on any of the above products.*

SINCE 1901 S-A STEPHENS-ADAMSON MFG. CO.

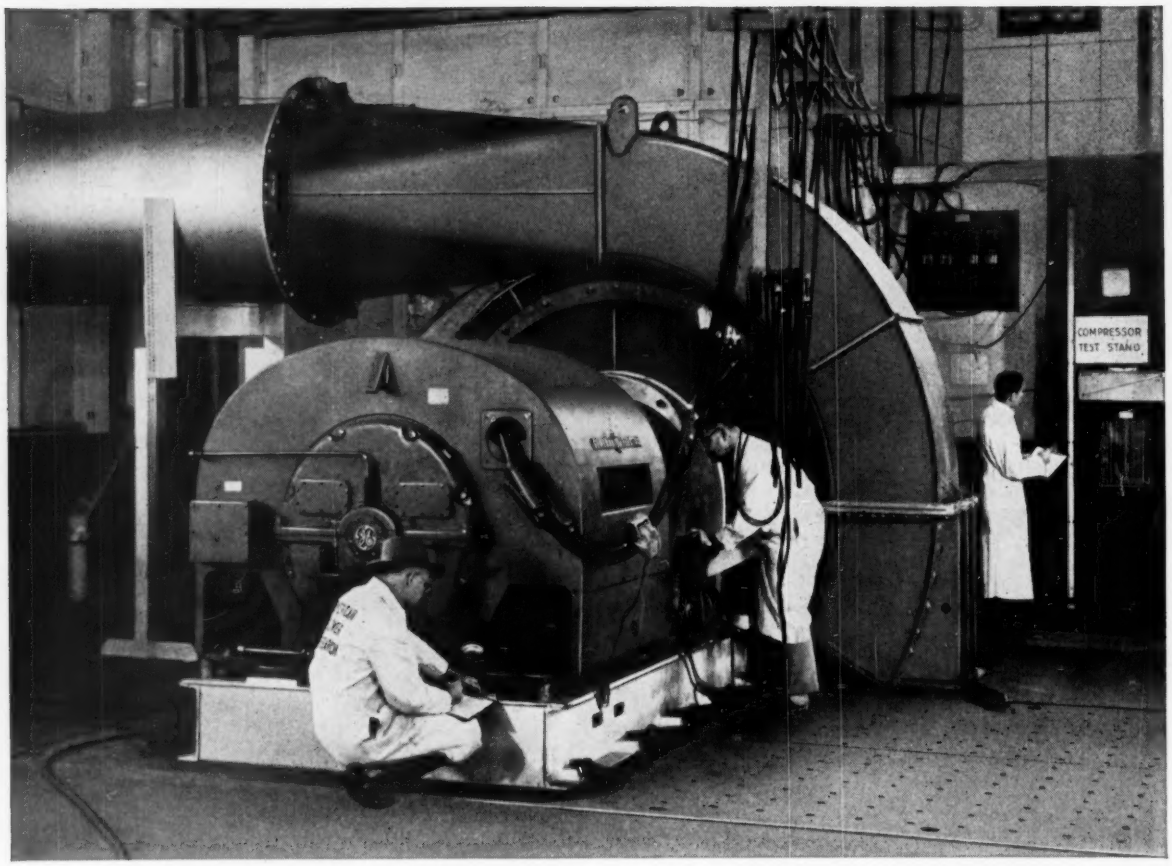
STEPHENS-ADAMSON MFG. CO.

5 RIDGEWAY AVENUE, AURORA, ILLINOIS

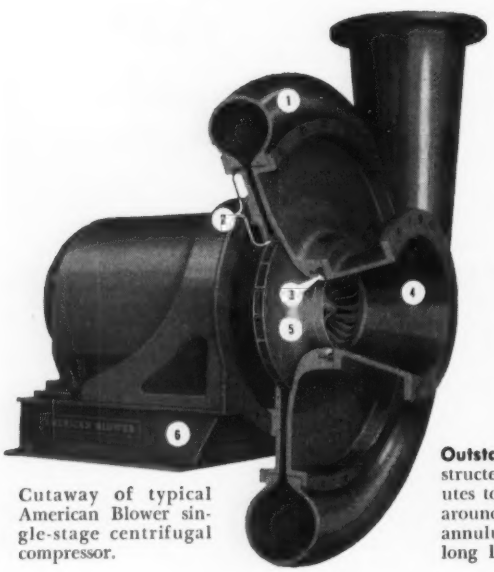
LOS ANGELES, CALIFORNIA

BELLEVILLE, ONTARIO

Here's the latest air-handling



LABORATORY TESTED CENTRIFUGAL COMPRESSOR DELIVERS 330,805 POUNDS OF AIR PER HOUR!



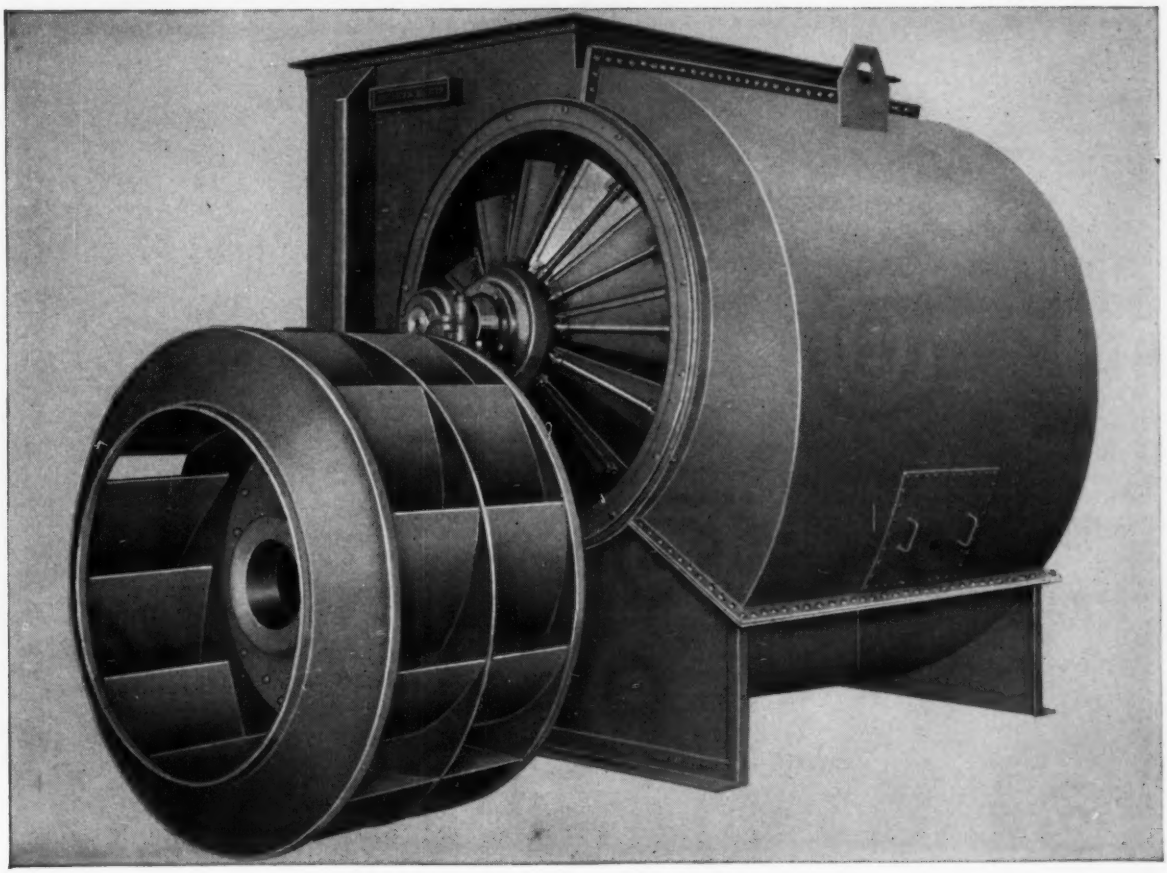
Cutaway of typical American Blower single-stage centrifugal compressor.

With the trend toward higher pressure requirements, American Blower has designed and built centrifugal compressors to furnish air for cyclone fired boilers. These compressors incorporate the use of a horizontally split, welded steel volute casing, variable inlet guide vanes, welded steel impeller of the shrouded type with impeller shaft supported by two journal bearings plus a Kingsbury thrust bearing arranged for positive forced-feed lubrication. This highly efficient compressor is driven by a 1000 HP, 1800 rpm, induction motor, delivers 330,805 pounds of air per hour at a static discharge pressure of 67.5 inches water gauge.

Like every American Blower single-stage centrifugal compressor – 30 to 2250 HP – this compressor has been completely tested in accordance with the A.S.M.E. Power Test Code. Such testing guarantees the mechanical operation and performance of all American Blower compressors.

Outstanding features: (1) Improved scroll-shaped casing design. (2) Unobstructed long diffuser passage converts velocity energy into pressure, contributes to quiet operation. (3) Annulus packing minimizes recirculation of gas around impeller inlet. (4) Removable inlet nozzle for accurate alignment of annulus packing. (5) Aero-dynamic design of impeller blades for high efficiency, long life. (6) Welded-steel baseplate "stress relieved" prior to machining.

equipment from American Blower

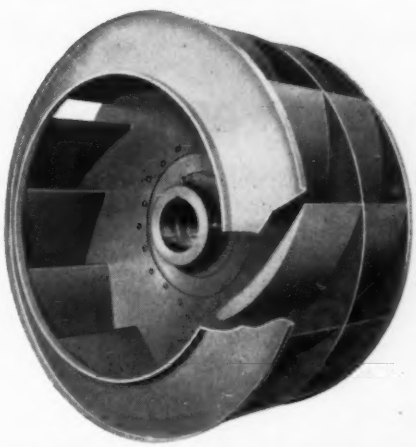


AIRFOIL FAN HAS ADVANCED DESIGN FOR HIGH EFFICIENCY, LOW OPERATING COST

Featuring a functionally designed airfoil blade, American Blower's improved Airfoil Fan is the industry's best in the non-overloading-horsepower type of centrifugal fan.

That's because smooth interworking of improved streamline inlets, wheel rims, and housing minimizes turbulence, resulting in higher efficiency, lower power consumption. The non-overloading-horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

Why not talk to an American Blower sales engineer about *your* requirements. His knowledge of air-handling applications can prove invaluable to you. Call our nearest branch office, or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products.

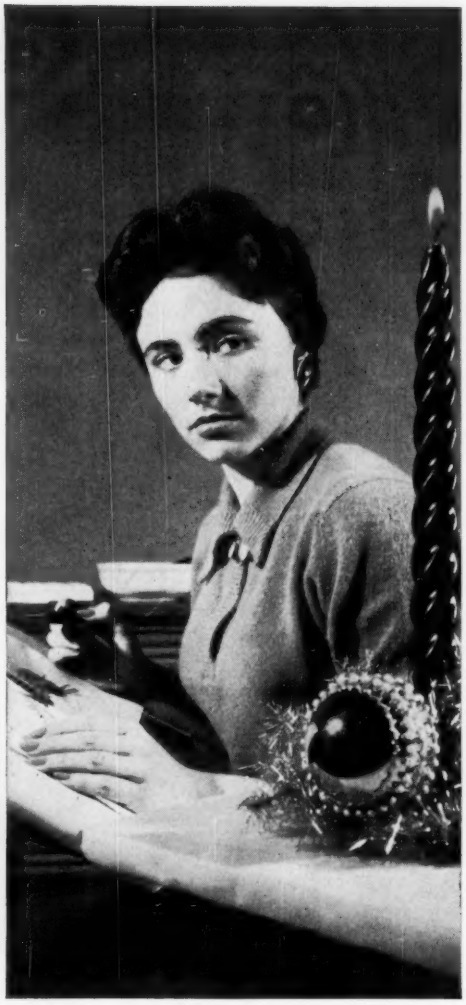


Special design of the airfoil blade and matching streamline inlet are the top features of American Blower Airfoil Fan. The dieformed, reinforced, and welded blades are extra strong, extremely efficient. Single- and double-inlet Airfoil Fans are available in many sizes, and for volumes up to 1,000,000 cfm.

AMERICAN BLOWER

Division of AMERICAN-Standard

Conditioned air is supplied by 45 single-zone and 10 multi-zone units. Johnson equipment is shown above controlling outdoor air and return air dampers and hot and chilled water supplies on a typical production area unit. Space conditions are controlled by Room Thermostats and Room Humidostats.



Refreshing, perfectly regulated temperatures add to the efficiency of Hallmark's all-important creative staff. Many companies report that properly controlled air conditioning not only improves worker performance but helps reduce absenteeism and turnover and makes recruiting easier.

Fast response to load shifts is a must in the 600-seat cafeteria. Sensitive Johnson Thermostats and Humidostats quickly compensate for changes in occupancy, hold temperature and humidity at ideal comfort levels. Stage and projection equipment permit the dining area to be used also for company functions.

YOU CAN DO IT BETTER with JOHNSON PNEUMATIC CONTROL

1. Greater Simplicity—pneumatic control involves far fewer and much simpler components than anything else you can use.

2. Ease of Operation—inexpensive control pressure gauges, exclusive with pneumatic systems, give you unlimited freedom to observe and direct system operation.

3. Choice of Features—widest choice of operating features to match your needs. Johnson makes the most complete line of pneumatic temperature, humidity and pressure control equipment.

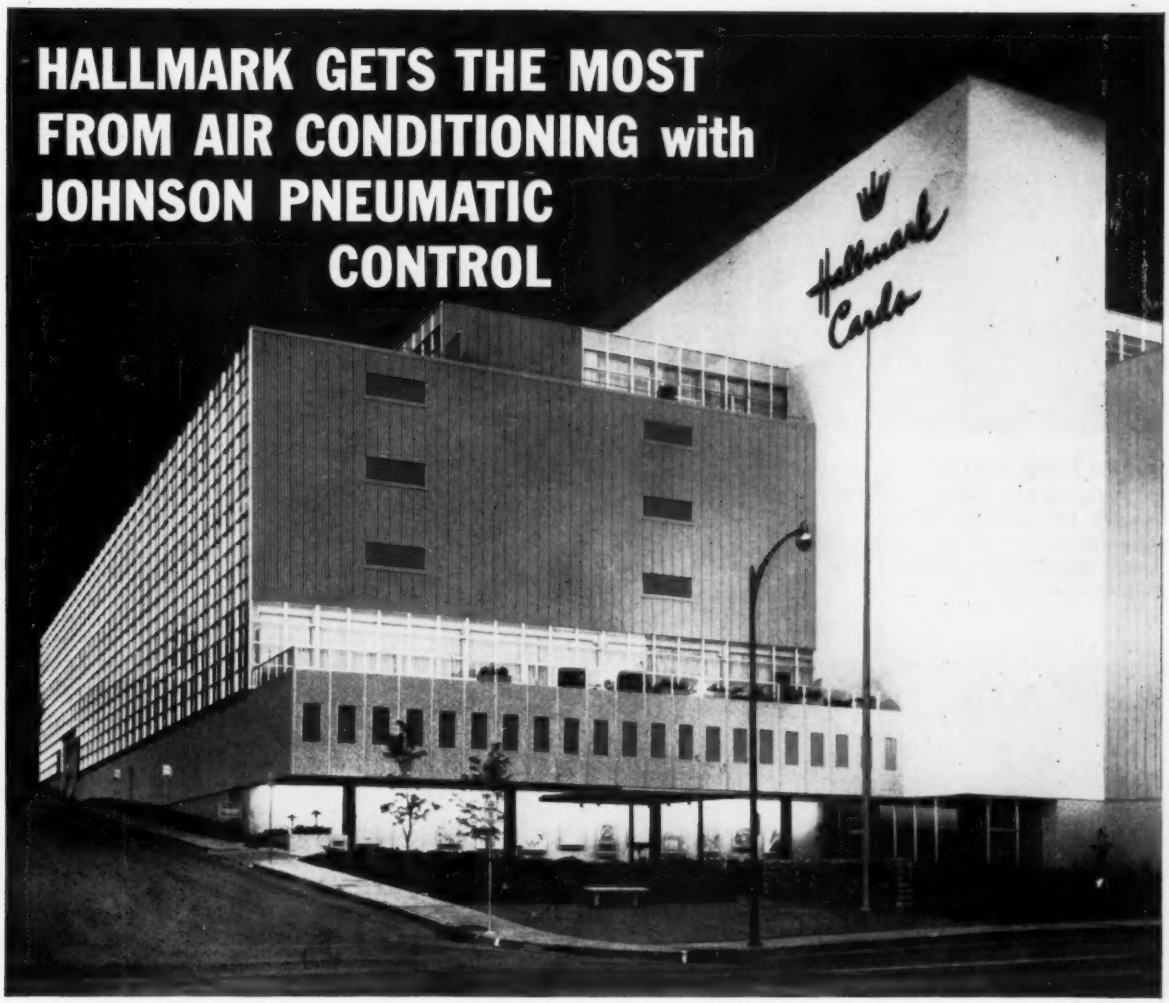
4. Less Upkeep—there are fewer components to check, fewer parts subject to failure.

5. Reliable Performance—Johnson Pneumatic Control is unaffected by short circuits, electrical overloads, voltage variations and humidity. You get continuous, accurate control.

6. Complete Safety—even in the presence of explosive gases, solvents, dusts and other hazardous materials.

7. Maximum Flexibility—a big "plus" value in industrial work. No matter how exacting your needs, Johnson Pneumatic Control can produce the results required. It can be applied to any type or make of air conditioning, heating or ventilating system. Each Johnson System is engineered and installed to suit the requirements of the individual installation.

HALLMARK GETS THE MOST FROM AIR CONDITIONING with JOHNSON PNEUMATIC CONTROL



Hallmark Cards, Inc., Kansas City, Missouri. Welton Becket & Associates, architects and engineers; Long Construction Co., general contractor; Interstate Heating & Plumbing Co., mechanical contractors; all of Kansas City.

Multi-Purpose Pneumatic Control System Helps Solve Diversified Production Problems, Insures Made-To-Order Working Climate

Precision regulation of temperatures and humidities makes important contributions to production efficiency in the new air conditioned home of Hallmark Cards. The "brainwork" for the air conditioning system is done by a Johnson Pneumatic Control System that matches temperature and humidity conditions to the exact needs of the work carried on in each room and area of the 760,000 sq. ft. building.

Effective control has simplified numerous problems of handling temperature- and humidity-sensitive paper stock and helps make possible consistent, high speed, quality production of famous Hallmark greeting cards.

Equally important is the provision of an ideally controlled environment for Hallmark's creative staff and office employees.

Proper control of industrial air conditioning, heating and ventilating systems is becoming increasingly important as a means of improving production, cutting costs and adding to worker efficiency. Johnson's experience in planning and installing the pneumatic control systems of countless industrial buildings can be applied profitably to your problems. An engineer from a nearby branch office will gladly give you his recommendations without obligation. Johnson Service Company, Milwaukee 1, Wisconsin. Direct Branch Offices in Principal Cities.

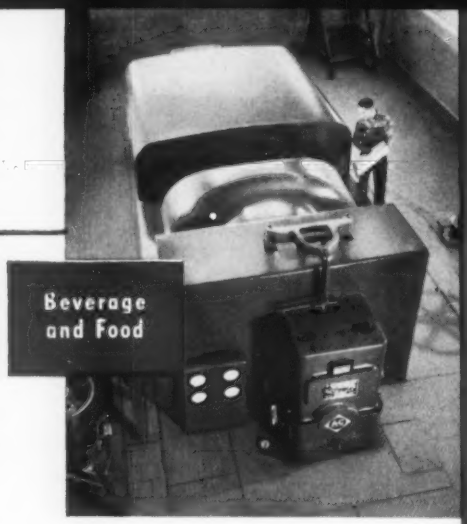
JOHNSON CONTROL

PNEUMATIC SYSTEMS

PLANNING • MANUFACTURING • INSTALLING • SINCE 1885

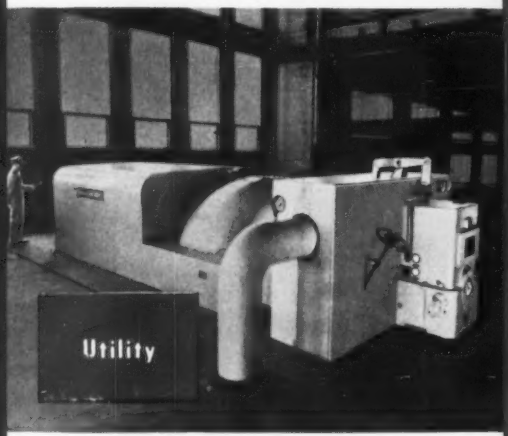
ALLIS-CHALMERS STEAM

The Choice of



ONE OF THREE Allis-Chalmers steam turbine generator units in a large brewery. This 5000-kw condensing, automatic extraction, impulse unit generates electricity as a by-product of process steam.

LARGE QUANTITIES of steam are required for heating, laundry, and other services. These 3000-kw Allis-Chalmers non-condensing, automatic extraction turbine-generator units supply steam at two pressures as well as electric power.



A MINNESOTA CITY supplies business district and residential heating steam, and electric power with this recently installed 7500-kw condensing, automatic extraction steam turbine generator unit.

THIS 5000-kw condensing steam turbine generator unit was designed to meet the special requirements of a nuclear power plant. In addition, Allis-Chalmers supplied the switchgear, condenser, pumps, motors and other auxiliaries.

TURBINE GENERATOR UNITS

Modern Power Plants

Condensing . . . non-condensing and automatic extraction units are available for wide range of services

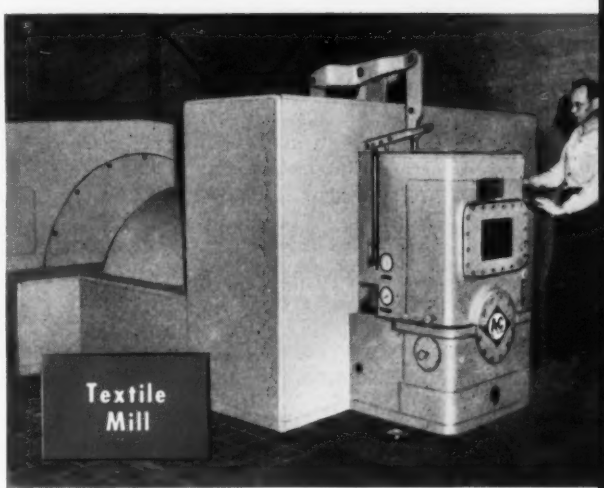
UTILITIES, breweries, textile mills, medical institutions, and a nuclear power plant enjoy the low installation and operating costs of Allis-Chalmers WA-Series steam turbine generator units.

These modern, compact units complement the most modern plant design. They are built in NEMA ratings through 10,000 kw . . . AIEE-ASME preferred ratings to and including 16,500 kw.

Users of these Allis-Chalmers turbines enjoy an important advantage. "Big turbine" features are incorporated in their design.

For example, the centrifugal-type speed governor is the same type used in large Allis-Chalmers steam turbines. Steam seals are the same labyrinth type used in turbines up to 300,000 kw. Removable external glands, high chrome alloy steel buckets and nozzles are other features. The 16,500-kw units with hydrogen-cooled generators have the same type of hydrogen seals as used on the large sizes.

Unit shipment with rotors individually locked in place cuts installation time and cost. Foundation cost is reduced because oil piping and generator air coolers are above the floor line.



PROCESS STEAM in a synthetic yarn plant produces electric power as a by-product with this 5000-kw non-condensing steam turbine generator unit.

GET MORE FACTS on these economical units. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

A-5437

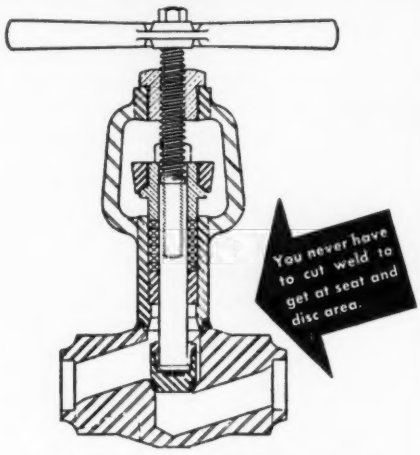
ALLIS-CHALMERS

Cut valve maintenance up to 75%

Install HANCOCK 1500# and 2500# Steel Valves

• Every power plant maintenance man will agree that a lot of valuable time is lost when hours must be spent in servicing a single high pressure valve. That is why Hancock 1500# and 2500# Steel Valves are preferred for high-temperature steam lines. They rarely require attention, but when maintenance is needed, the work takes as little as one-fourth the time ordinary high pressure valves demand. Hancock Valves stay in the line for servicing. There is no danger of ruining internal parts. The bonnet weld is permanent—never has to be cut to get at the seat and disc area.

Most design and operating engineers in modern steam plants specify these high pressure Hancock Valves with maintenance requirements in mind. There is no bonnet joint to leak, no gasket to leak, no seat insert to leak! In design, in quality, in construction—in every respect—Hancock 1500# and 2500# Steel Valves have every feature essential to protect personnel, plant and service to customers. So, when you replace high pressure valves, remember that *when Hancocks go in, valve costs go down!*



SIZES: ¼" through 2". Outside screw and yoke.

SERVICE RATINGS: Screwed and socket weld ends: For all pressures up to 2500 psi at 1050° F., O.W.G. 6000 psi—100° F.

Flanged Ends: For all pressures up to 1500 psi at 900° F., O.W.G. 3600 psi—100° F.

Integral hard faced seats, hard faced discs.

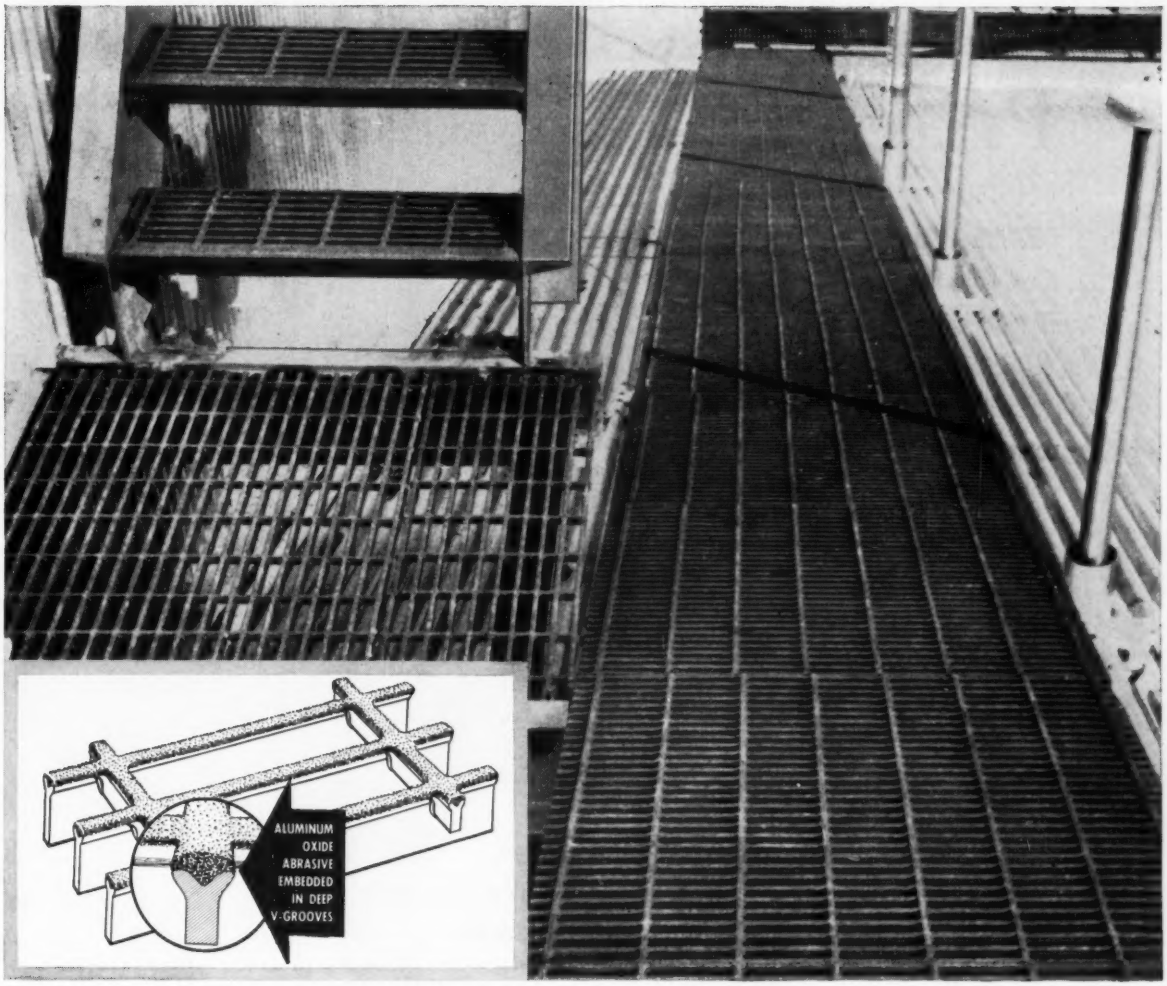
CALL YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for help in meeting your needs for revalving projects and new construction. You can depend on his recommendation to save you time, trouble and expense.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



RELGRIT® provides safe footing on sharply sloping roofs at AEC St. Louis Plant

Reliance Relgrit gratings and treads are providing safe access to stacks, filters and other equipment across the 18° sloping roof of the AEC Feed Material Plant near St. Louis. The abrasive surface of Relgrit was picked as a truly non-skid surface for ramps, stairways and walks leading to equipment which had to be serviced frequently.

The top surfaces of the bearing bars have ⅛" deep V-grooves in which is embedded aluminum oxide abrasive grains in a hard resin. The material is not affected by water, oil, gasoline, greases, or the most commonly used acids, alkalis and other chemicals, which gives it a long service life under the most severe conditions. If you have operations in which the floors become oily, greasy, wet, or slick from any other cause, Relgrit can provide safe footing at very low cost. Write for complete information and samples.

you can't slip on Relgrit

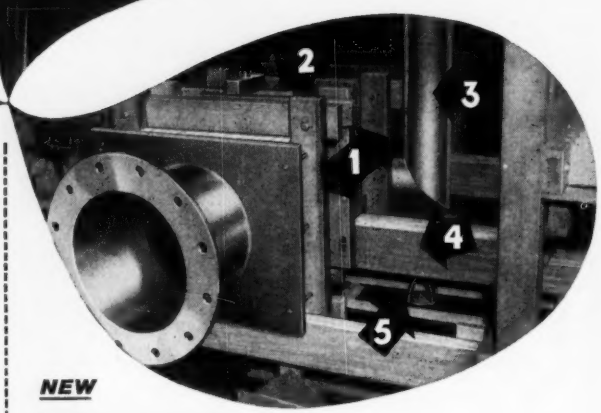
Reliance Steel Products Company

P. O. BOX 510-J, McKeesport (Pittsburgh District), Pa.

Relgrit Abrasive Gratings and Treads • Lightweight Bridge Flooring
Steel, Stainless and Aluminum Grating • Steel Mill Equipment

Pritchard

INDUSTRIAL
COOLING TOWERS
HAVE NEW FEATURES
FOR BETTER
PERFORMANCE . . .
EASIER
MAINTENANCE



NEW

DRIFT ELIMINATORS

The NEW drift eliminators in Pritchard counterflow cooling towers are supported from the framework for ease of erection and the slip-fit blades are easily removable for access to the laterals of the distribution system as illustrated. The drift eliminator sections over the main distribution header are removable in pre-fabricated units for quick servicing. These NEW eliminators are a full 6-feet below the fan deck, providing a fan plenum chamber, with ample head room for easy servicing and inspection.

WRITE TODAY FOR FREE BROCHURE

Between the covers of "Answers to the 15 Questions About Pritchard Induced Draft Cooling Towers," you will find a wealth of helpful information. Information that will assist you in selecting your cooling tower. Write today on your company letterhead for your FREE copy. No obligation, of course.

NEW

DISTRIBUTION SYSTEM

The Pritchard tower employs the closed All Heart Redwood distribution system providing better water distribution and trouble-free performance. To this time tested system have been added several NEW features:

1. NEW Main Header . . . made of 1½" T&G with splined joints between panels for leak-proof construction.
2. NEW Top Cover . . . panel is easily removed for inspection or clean-out.
3. NEW Relief Vent . . . stand-pipe prevents damage from overpumping and eliminates danger of blowing out header.
4. NEW Laterals . . . of simplified construction with splined joints. Each lateral has easy-to-remove end plug for fast, easy flushing.
5. NEW Non-Clogging Distributors . . . made in one piece to assure steady, even flow of water over tower fill.

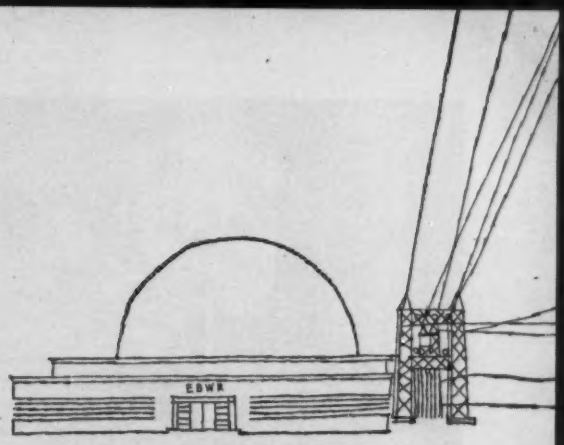
INDUSTRY'S PARTNER FOR PROGRESS

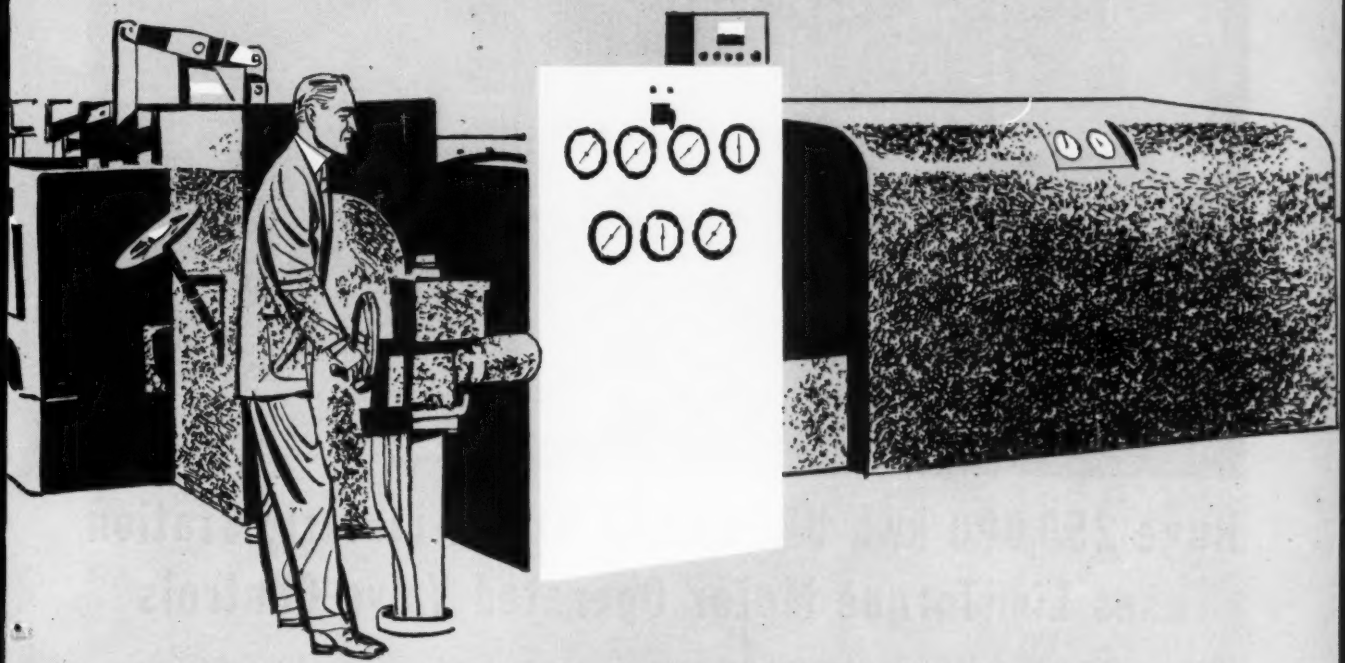
COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 578, 4625 Roanoke Parkway, Kansas City 12, Mo.

STANDARD OIL PRODUCT HAS ROLE IN HISTORY-MAKING EVENT





Last December at Argonne National Laboratory, Lemont, Illinois, the Experimental Boiling Water Reactor achieved its design power level of 5,000 kw. for the first time. The lubricating oil in the Allis-Chalmers turbine was Standard's NONPAREIL Turbine Oil.

In a boiling water reactor, live steam is generated in the uranium core and piped to the turbine. There is no coal pile on the site and no ash heap. The reactor consumes less than an ounce of uranium in 24 hours. While the unit is regarded as a tool for research, it is now supplying an important part of the electrical energy required by this 2,700 man laboratory.

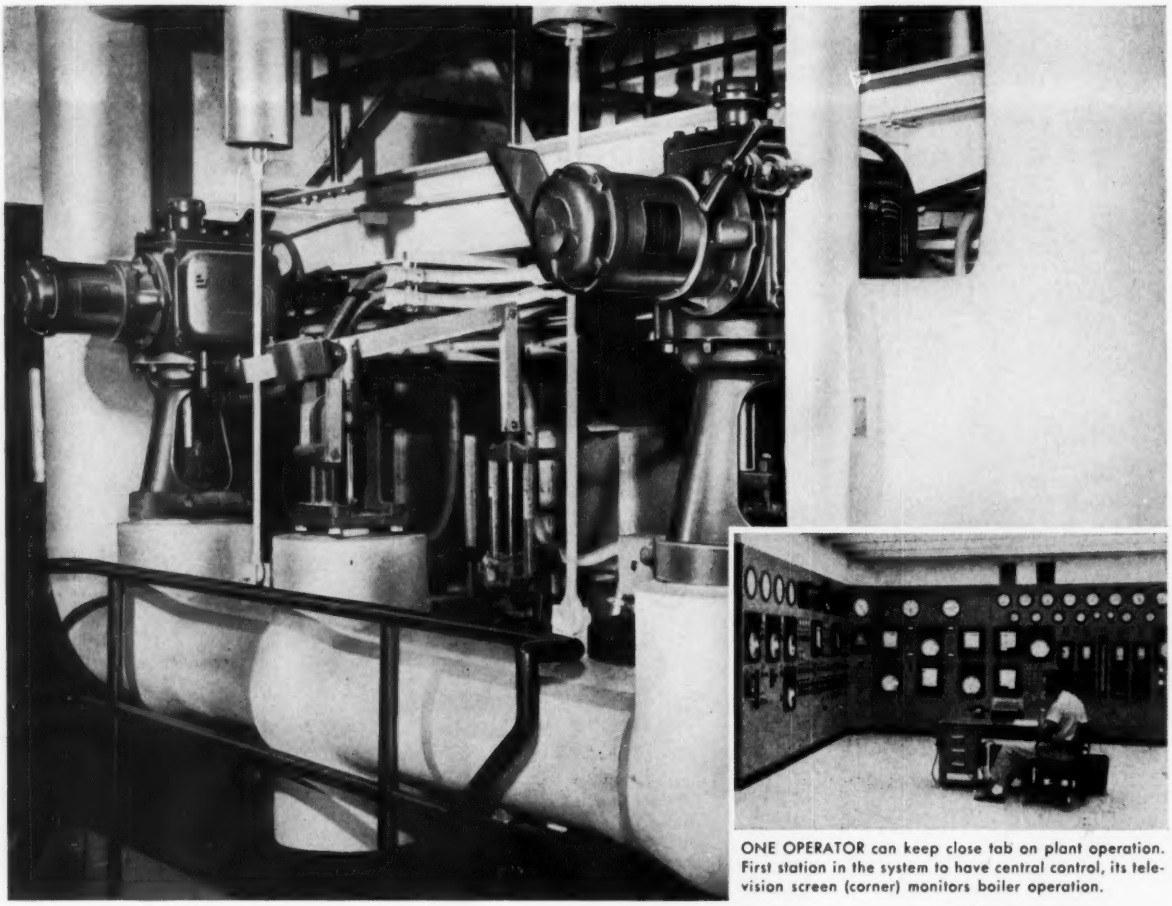
Near the turbine of this history-making research tool will hang a framed guarantee certificate. This document will certify that the 350 gallon fill of NONPAREIL Turbine Oil is *guaranteed for the life of the turbine.* More than 1,800 of these certificates have been issued; the first one more than 30 years ago. The guarantee still stands.

As with every NONPAREIL Turbine Oil installation, an additional technical service is performed. Standard Oil men with engineering training and long experience in lubrication work take samples of the oil for analysis twice yearly to make sure the oil continues to meet guarantee conditions. In the case of Argonne National Laboratory, industrial lubrication specialists from Standard Oil's division office in Joliet, only a few miles away, do this work.

Such service as this is available to you from your nearby Standard Oil office anywhere in the 15 Midwest and Rocky Mountain states. Call there. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY
(Indiana)



ONE OPERATOR can keep close tab on plant operation. First station in the system to have central control, its television screen (corner) monitors boiler operation.

Huge 250,000 kwh URQUHART Steam-Electric Station uses LimiTorque Motor Operated Valve Controls

This new plant, operated by the South Carolina Generating Company, a subsidiary of South Carolina Electric and Gas, is one of the largest, most modern and efficient Central Stations in the World—We are proud that LimiTorque push-button Valve Controls were chosen for such an important job.

Shown above are two LimiTorque Controls on Crane 10" Pressure-seal Bonnet Gate Valves, operating at 2,200 psi and 475°F. LimiTorque is also used on a 10" Crane Pressure-seal Wedge Gate Valve controlling the flow on a 1660 GPM Boiler Feed Pump, operating at 1975 psi and 1,775°F.

LimiTorque Valve Operators were chosen for this Station (and for many other leading Stations during the past 20 years) because of their absolute dependability, safety, operating economy and long service-life.

LimiTorque is, by far, the most widely used valve operator in the World . . . Send for complete Catalog L-550, on your Business Letterhead.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET. PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

WHAT'S SPECIAL ABOUT LJUNGSTROM®

structural details?

. . . many things.

And all make air preheating with a Ljungstrom more economical, less troublesome. The Ljungstrom offers these refinements:

- The welded steel rotor is strong enough to support the heating elements without strain, yet flexible enough to withstand extreme temperature variations.
- An inspection port and strategically located access doors reveal any maintenance needs and make replacement work routine.
- A mass flow soot blower is installed as original equipment at the cold end where deposits are most apt to accumulate.
- The hot end heating surface is made from open hearth steel sheet and the cold end from heavier gauge, low-alloy corrosion-resisting material because corrosion is normally confined to the cold end.

The Air Preheater Corp. is constantly working to improve Ljungstrom heating surfaces, seals, bearings, and other structural details. And, in general, these improvements can be applied to existing units with only minor changes and at nominal cost. Another reason why seven out of ten air preheating installations are Ljungstrom. For the full story on how the Ljungstrom design and construction can cut your fuel costs, increase plant efficiency, write for our 38-page manual.

The Air Preheater Corporation, 60 EAST 42ND STREET, NEW YORK 17, N. Y.

A question for every electric utility

JUST HOW FLEXIBLE CAN POWER SUPPLY GET?

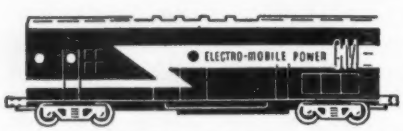
Giant strides to improve flexibility of supply to customers have been taken in recent decades by the electric utility industry. Today power availability must anticipate load growth more than ever before. Inter-connected supply permits transferal of power from one area to another as varying geographical load demands or emergency situations arise.

Even greater flexibility, however, can be attained—by means of Electro-Mobile Power. Truck-trailer or rail units permit shifting increments of power from place to place as demands change. Units can be used singly or in multiple—added like building blocks to match requirements exactly. And provision for impulse starting and stopping allows unattended operation from any location in the system.

Moreover, the placement of Electro-Mobile Power close to the load not only relieves the central station of a block of power, but also reduces the line loss between the central station and the load for that block of power. This is a major factor at time of peak.

Just how flexible can service get? Far more flexible than you might imagine with present equipment if Electro-Mobile Power is employed to answer additional requirements. A joint analysis of your system can reveal the savings and increased flexibility possible with these units. Contact your Electro-Motive representative for full information.

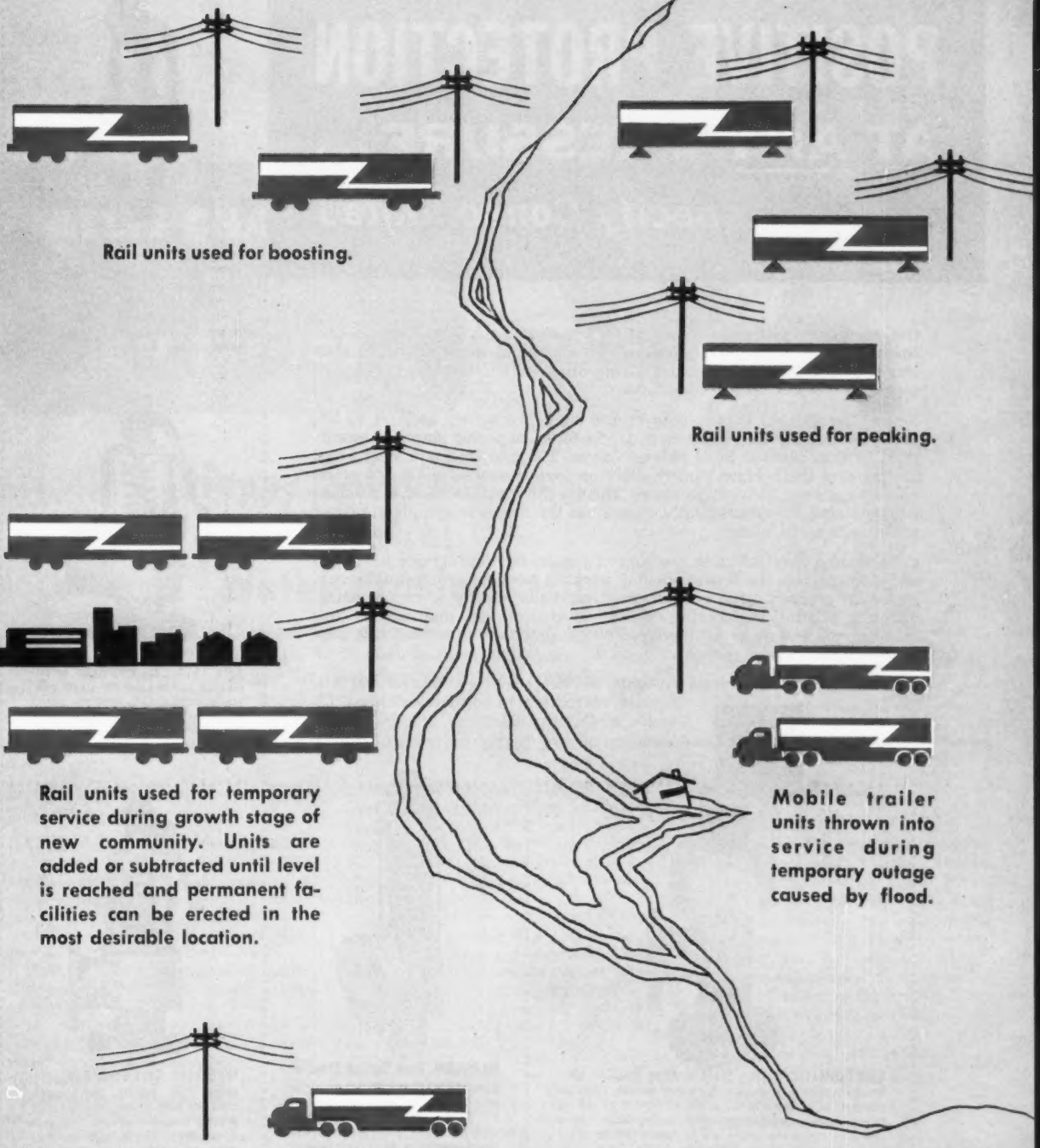
Electro-Mobile Power adds to system flexibility in many ways



RAIL CAR—1000 kw units for use on sidings or placed on piers for semi-permanent use.

TRUCK TRAILER—500 kw units offer excellent mobility for many temporary applications.

Representative electric utility companies across the country are now providing better service to customers through the use of Electro-Mobile Power. This diagram is a composite of the different jobs these units, both truck-trailer and rail, are performing. Detailed information on these applications—operating costs, KWH produced, reason for use, location, etc.—are available through your Electro-Motive representative.



Rail units used for boosting.

Rail units used for peaking.

Rail units used for temporary service during growth stage of new community. Units are added or subtracted until level is reached and permanent facilities can be erected in the most desirable location.

Mobile trailer units thrown into service during temporary outage caused by flood.

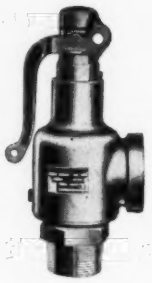
Mobile trailer units being used during line relocation resulting from new highway construction.

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS

LA GRANGE, ILLINOIS

Sales Offices in Chicago, New York, St. Louis, San Francisco

POSITIVE PROTECTION
AT ANY PRESSURE...
specify Consolidated



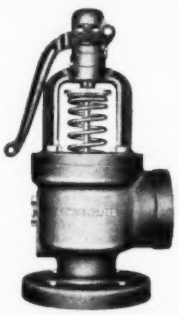
TYPE 1551. Cast Bronze Body. For package-type and fire tube boilers, air tanks and other classes of unfired pressure vessels. **Sizes:** ⅜" through 3". **Pressures:** up to 300 psi. **Temperatures:** up to 450° F.

Get protection you can be sure of — whatever your working pressure. Specify Consolidated Safety Valves. Thousands of installations, in both large and small steam generating plants, attest to their complete reliability under all types of service conditions.

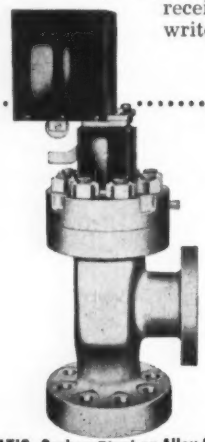
Many Consolidated Valves, with bronze body, are widely used for steam, air and water service; many more are installed in power plants as auxiliaries to Consolidated Steel Safety Valves. The cast iron and steel types are proving their dependability daily on low pressure boilers and those operated at super-critical pressures. The five different Consolidated Valves pictured here are representative types but the line is so complete, proper selection is no problem.

Consolidated Safety Valves are ruggedly built for long service life. Each type incorporates the fewest possible working parts for greatest efficiency. Precision craftsmanship assures positive, tight closing after operation. Through skillful engineering, valve adjustment and maintenance are made simple and easy. All these essentials contribute to outstanding performance, safety and economy.

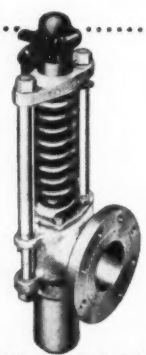
Just send us details of your particular service requirements and you will receive correct valve recommendations. Or write for Catalog 700A.



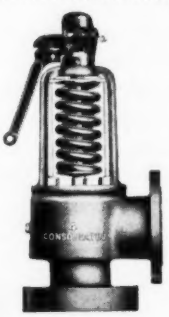
TYPE 1511. Cast Iron Body. An all-purpose safety valve for steam generator service. Cuts cost per pound of steam discharged. **Sizes:** 1½" through 6". **Pressures:** up to 250 psi. **Temperatures:** up to 450° F.



ELECTROMATIC. Carbon Steel or Alloy Steel. An electrically actuated relief valve for boiler service. Operable automatically, manually or cut out of service by setting remote control switch. Supplements spring-loaded safety valves — conserves power and increases efficiency of steam generating plants. **Sizes:** 2½" through 14". **Pressures:** up to 2500 psi. **Temperatures:** up to 1100° F.



MAXIFLOW. Cast Carbon Steel or Cast Alloy Steel. A safety valve with the greater discharge capacity and shorter blowdown demanded by high pressure, high temperature steam generators. **Sizes:** 1½" through 4". **Pressures:** up to 2500 psi. **Temperatures:** up to 1050° F.



TYPE 1415. Cast Steel Body. For water tube boilers, mechanically fired fire tube boilers, accumulators, unfired pressure vessels and pipelines. **Sizes:** ½" through 6". **Pressures:** up to 900 psi. **Temperatures:** up to 900° F.

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

ALLIS-CHALMERS

Water Conditioning

ON THE JOB

Happy Solutions To 4 Typical Water Problems

● Everybody seems to have problems when they use water. It's too pure, or it isn't pure enough . . . or it needs conditioning for the job it has to do. In any case, a specialist is needed. Here are typical examples of Allis-Chalmers water conditioning service, equipment and chemicals at work solving varied water problems.

Drought Adds to Woes of River Water Users

CALIFORNIA—Things looked bad at a paper company when the first water samples came in. In fact, one water conditioning company went so far as to say that the alkalinity of the water could never be reduced to a satisfactory level.

But on the assurance of Allis-Chalmers experts, a de-alkalizer was ordered for boiler make-up water.

In the meantime there was a drought. The drought made the river water conditions even worse than they had been, so that by the time the equipment was installed there was real trouble with alkali.

Allis-Chalmers engineers had an unusually tough problem on their hands. Instruction, experiment, on-the-spot service, and a program of constant control have resulted in production of satisfactory boiler make-up.

Saved $60,000 in New Equipment

LOUISIANA—A low pressure industrial steam plant was being supplemented by a 1250-lb boiler. The question arose—can any of the old water conditioning system be used? Preliminary investigation indicated the need for demineralization equipment to get the desired water quality for make-up in the new equipment.

A survey of the records showed that it would be possible to use condensate from the low pressure system as make-up for the high pressure system. This solution of the problem required less modification of equipment than was originally anticipated . . . saved an estimated $60,000.

Stained Glass Has Its Place, But Not in Nursery

ILLINOIS—A nursery was spraying water over the outside of its glass hothouses to control the temperature inside. The method was effective, but the iron stains from the water were troublesome. Allis-Chalmers water conditioning experts recommended A-C's 130 Series complexing agents. This did the job by preventing the iron from depositing on the glass.

Battle with Algae Ends in Knockout

KENTUCKY—A petroleum company is finding out what a lethal weapon Allis-Chalmers new 120 Series algaecide really is. Previously they used sodium hypochlorite, but their cooling tower algae problems were not solved. Now they have complete control . . . using concentrations of only one-half of what is normally recommended. They also say it's easier to handle and apply, and better in every way, than anything they've ever used before.

Get Help on Your Water Problems

Whether you need chemicals, equipment or service, Allis-Chalmers provides an unbiased recommendation based on over 25 years' experience. No problem is too big or too small. Specialists are located in many cities. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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A-5304

HERE'S HOW:
ALCO'S EXPERIENCE BENEFITS YOU

Reasons why leading power companies incorporate ALCO equipment in new stations and units

For over 30 years ALCO has designed and built power-plant equipment for the country's largest steam-electric generating stations. The reasons for this success are unequaled thermal engineering and an uncompromising quality of manufacture. These ALCO values are your assurance that ALCO feedwater heaters, evaporators or prefabricated pipe will be engineered and manufactured to return a profit on your investment.

ALCO leadership in power-plant equipment is evidenced by an electronic-computer center for thermal calculations, new full-scale thermal laboratory, as well as complete research facilities. ALCO product designs like the Type "D" heater closure, various steam and nuclear exchangers, prove this leadership.

Investigate ALCO's qualifications when you next purchase equipment for a new station or unit. Specialists in the nearest ALCO sales office will help you. Or write Thermal Products Division, Dept. FHE-2, P.O. Box 1065, Schenectady 1, N. Y.

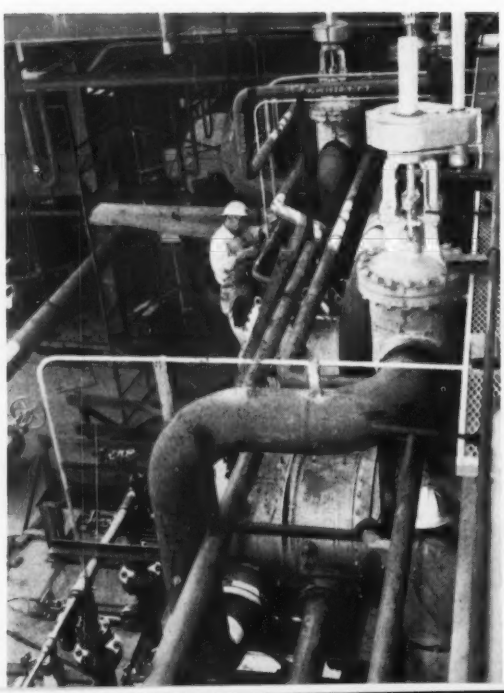
ALCO

ALCO PRODUCTS, INC.

NEW YORK

Sales Offices in Principal Cities

Locomotives • Diesel Engines • Nuclear Reactors • Heat Exchangers • Springs • Steel Pipe • Forgings • Weldments Oil-Field Equipment

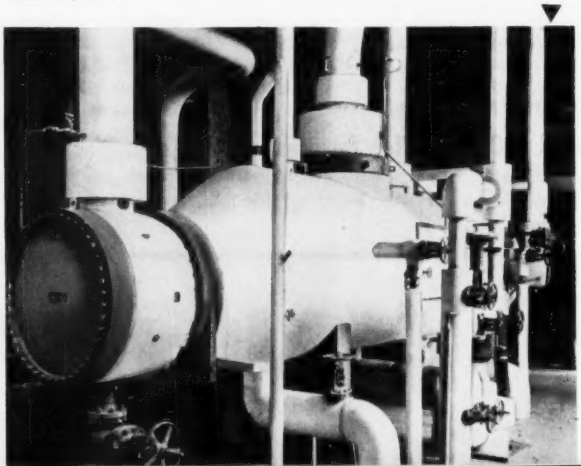


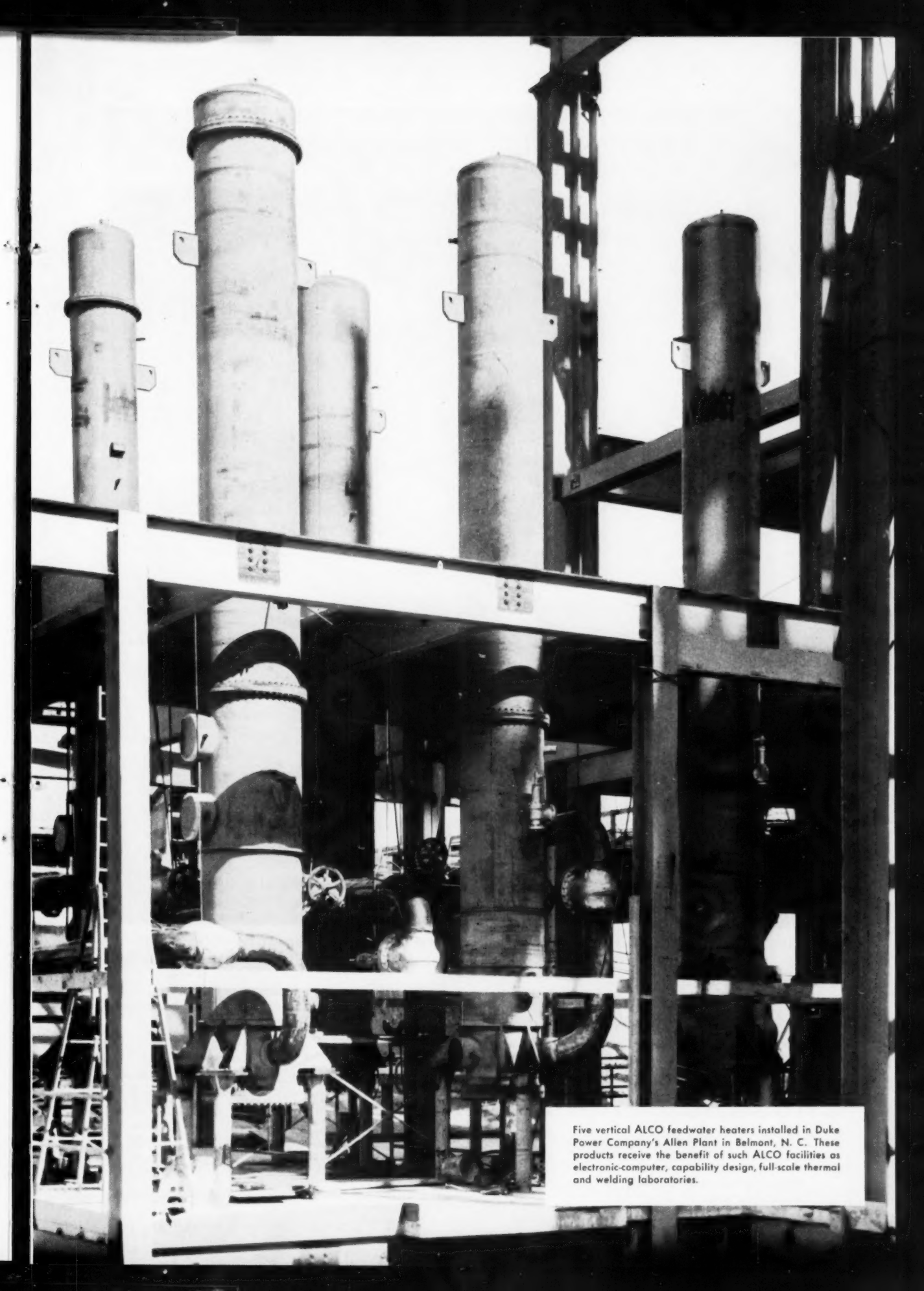
ALCO manufacturing experience and quality have gone into more than 20,000 ft. of prefabricated pipe for Florida Power & Light Company's Fort Lauderdale Plant extension. Diameters range from 1½ in. to 24 in.

◀

Evaporators manufactured by ALCO offer a simple and reliable means of producing a continuous supply of high-purity, distilled make-up water. Installation is at the Niagara Mohawk Power Corporation station in Dunkirk, N. Y.

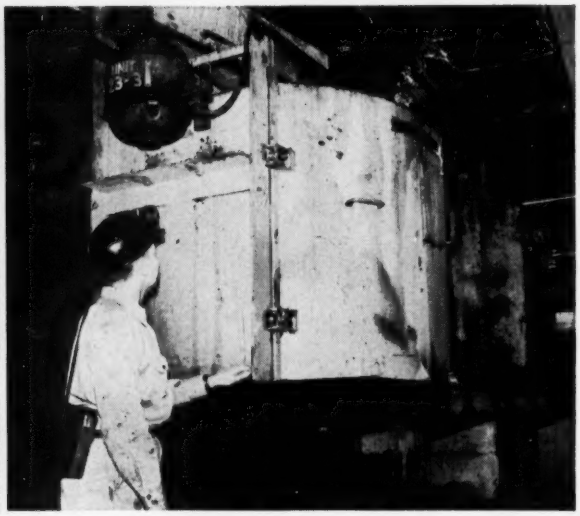
▼



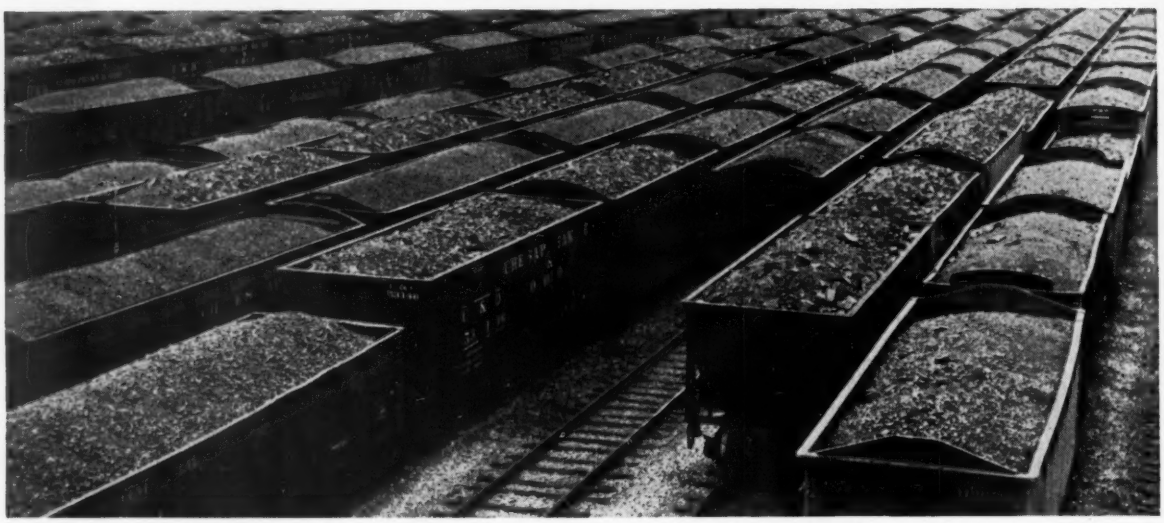


Five vertical ALCO feedwater heaters installed in Duke Power Company's Allen Plant in Belmont, N. C. These products receive the benefit of such ALCO facilities as electronic-computer, capability design, full-scale thermal and welding laboratories.

WHY CHESSIE'S RAILWAY IS FIRST IN COAL



SUPERIOR COAL. The naturally high quality coals produced on the C&O are processed to meet your specifications by modern methods and equipment. Here small sizes are being dewatered by a battery of vertical screens which do the job with a minimum of degradation.

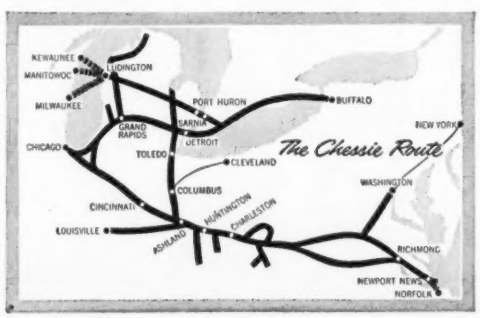


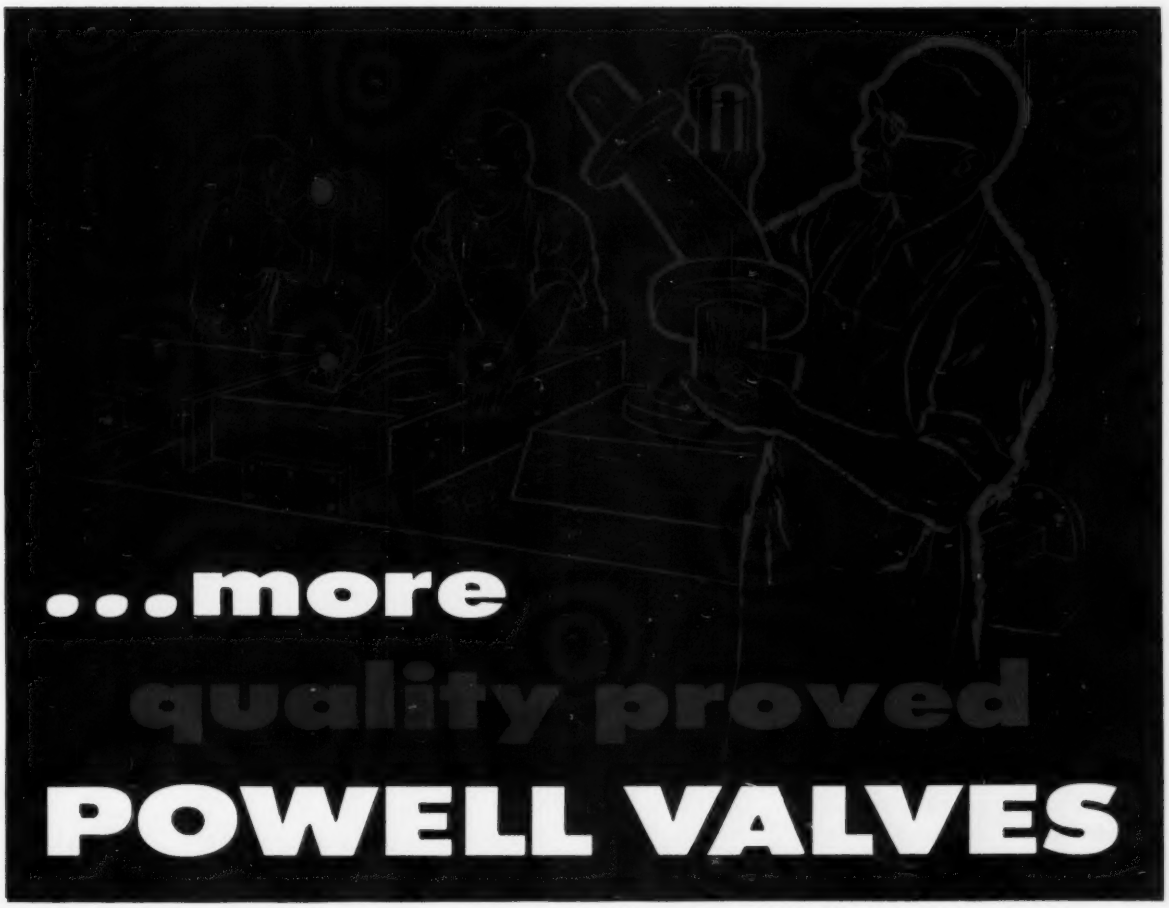
SUPERIOR SERVICE. Chesapeake and Ohio not only owns the world's largest fleet of coal cars—it keeps 99% of them operating by its prompt repair program. New automatic yards, new signal systems and ample power keep the cars rolling to insure on-time delivery.

For dependable deliveries of top quality coals, contact coal producers on the C&O. And for specific help in meeting your own fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL





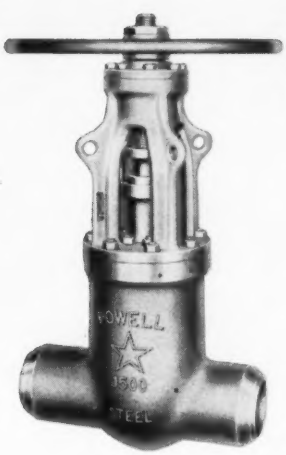


Fig. 11303—1500-Pound Cast Steel Pressure Seal Gate Valve.

Fig. 375—Bronze Gate Valve for 200 Pounds W.S.P. Union Bonnet. Inside Screw Rising Stem.

Fig. 11365—Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

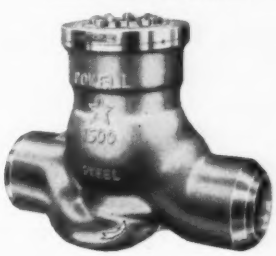
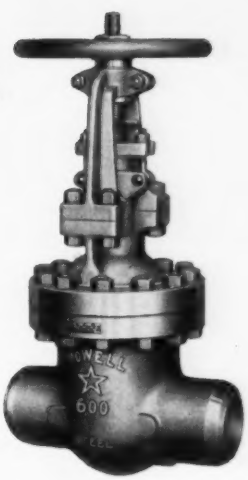


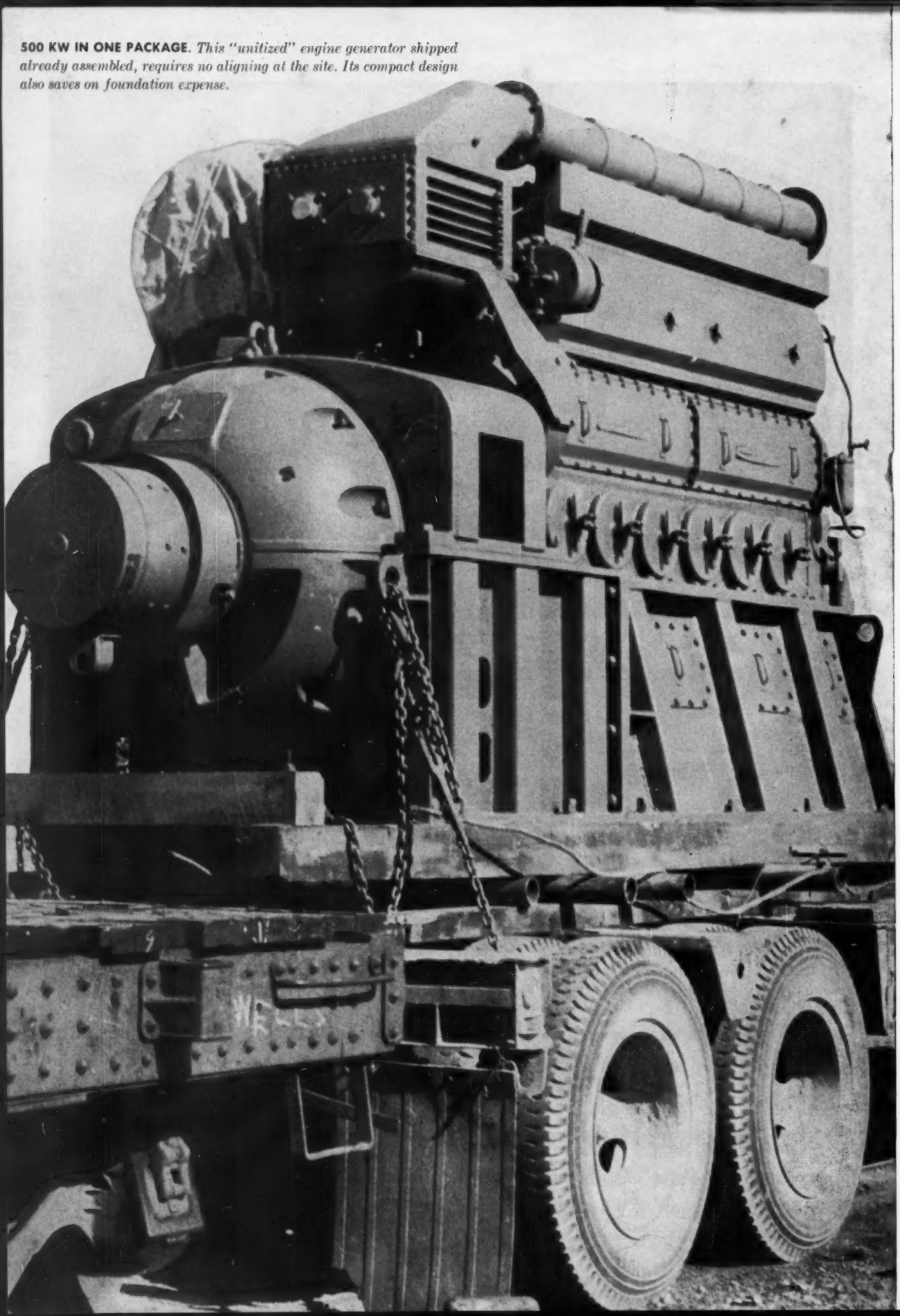
Fig. 6003-WE—Steel Gate Valve for 600 Pounds. Welding Ends. Outside Screw Rising Stem and Yoke.



for quality-crafted flow control

Ask your Powell Valve Distributor for the facts about quality-proved bronze, iron, steel and corrosion-resistant valves. Whatever your flow control problem, there's a Powell Valve to solve it.

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR



500 KW IN ONE PACKAGE. *This "unitized" engine generator shipped already assembled, requires no aligning at the site. Its compact design also saves on foundation expense.*

1957 POWER!

Long famed for reliability, Worthington 1957 power engines have many new features that can help you produce permanent or standby power at the lowest costs ever achieved for real *heavy-duty* units.

LOWER INSTALLATION COSTS—The new SW 9 engine you see at left has been "unitized" with its generator to drastically cut space requirements, installation time and expense. This design requires no aligning at the site. Should needs ever change, the entire unit can just as easily be picked up and moved to another location.

LOWER FUEL COSTS—In 1957, Worthington is pioneering in power by designing and building engines *specifically* for turbo-charged operation. The SW 14, for example, is America's first high output diesel built only for high pressure turbo-charging.

For economy today *and* tomorrow, all '57 Worthington power engines can be furnished to run on the lowest cost, locally available fuels—residual, crude, and distillate oils; natural, sewage, propane or manufactured gas.

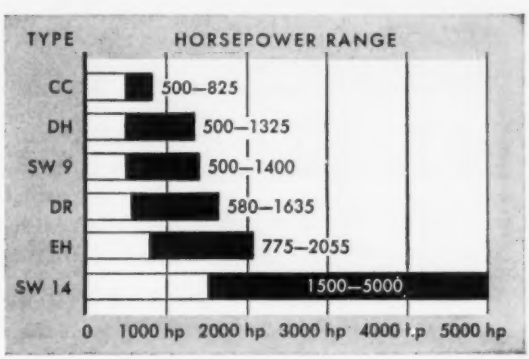
LOWER MAINTENANCE COSTS—With Worthington's 1957 engine line, you enjoy the economy of modern power design plus amazingly low maintenance. One of the many maintenance-saving features of the new SW 9, for example, is the Jet Swirl combustion chamber. The chamber is designed so that the air swirls as it enters the cylinder assuring rapid mixing of air and fuel for extremely clean combustion giving longer valve and liner life, as well as ultra-efficient operation.

The fact that every upper mechanical part is within reach from the operating level is another maintenance saving feature.

For reliable power in the 500 to 5,000 hp range, at the lowest possible cost, get in touch with your nearest Worthington District Office. Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont.

E-7-1

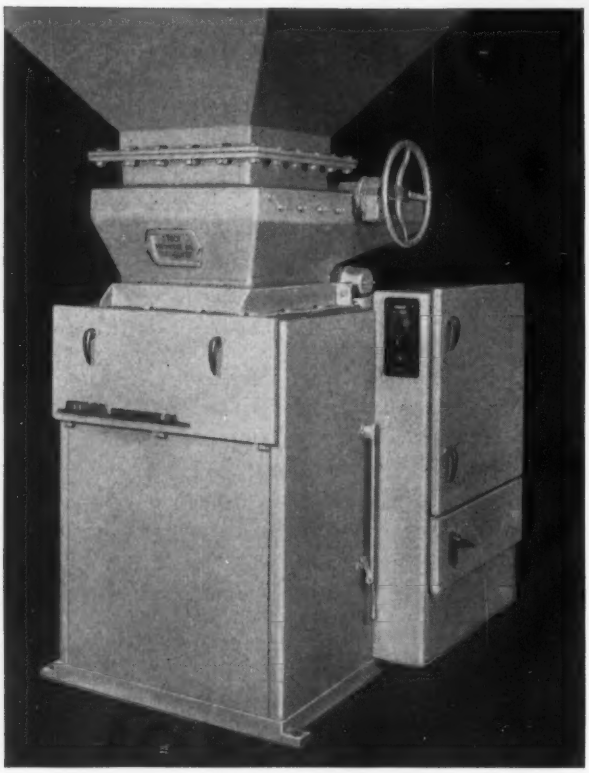
Choose your next diesel from Worthington's complete line of heavy-duty four-cycle power engines.



WORTHINGTON

The new Stock Equipment Co.
Model 50 Coal Scale offers:

ACCURATE, CONTINUOUS COAL WEIGHTS... WITHOUT FAIL!



with little or no attention

Day-in and day-out operation, twenty-four hours on end without interruption, is a necessity for modern central stations and industrial power plants. The demand is for equipment to handle higher tonnages with less manpower—and Stock Equipment Co. is meeting that demand with a constructive design program that keeps its entire line up-to-date.

For example: The new Model 50 Coal Scale handles higher tonnages easily with its 500# stainless steel weigh hopper, extra wide feed belt and unrestricted flow of coal 24" wide straight through the scale. Anti-friction bearings are used throughout. Even the feed belt is carried on closely spaced idlers with anti-friction bearings carefully arranged for pressure lubrication from one point on each side.

Seventeen years of designing scales exclusively for power plant use make a S-E-Co. Scale the answer to your coal weighing problem. Write for help with your particular layout of Bunker to Pulverizer or Bunker to Stoker equipment to the address below.

STOCK Equipment Company
745-P HANNA BLDG. CLEVELAND 15, OHIO

Values You Can't Specify

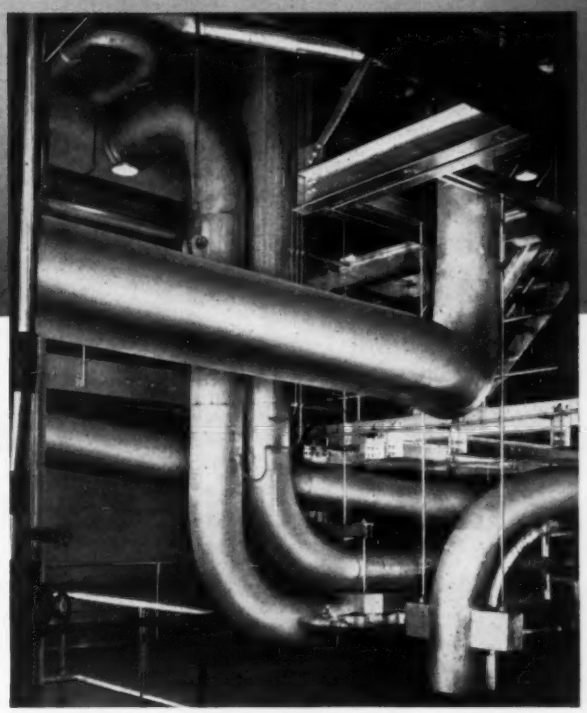
You Get Them in MIDWEST PIPING

In the fabrication and erection of every high pressure and/or high temperature piping installation, there are intangibles important to the success of the job . . . things that cannot be spelled out in the specifications but are essential to getting superior piping at an economical price.

Important among these is the experience of the fabricating and construction organization . . . experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. Midwest has fabricated and erected the piping on many critical jobs . . . including numerous atomic energy projects and Kyger Creek (the largest steam power plant ever handled completely by one piping contractor).

Another is a questioning attitude . . . a frame of mind that habitually asks (before the job is placed in the shop for fabrication): "Have the pre-fabricated sub-assemblies been so planned that the field work is minimized and simplified as much as possible?" Highly skilled Midwest piping engineers carefully analyze every job with this question in mind.

For power plant or process, the customer gets the most for his money when he buys Midwest Piping.



Main steam piping at Kyger Creek Plant which has a capacity of 1,075,000 kw and is the largest power plant piping contract (combining fabrication and erection) ever performed by a single contractor.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

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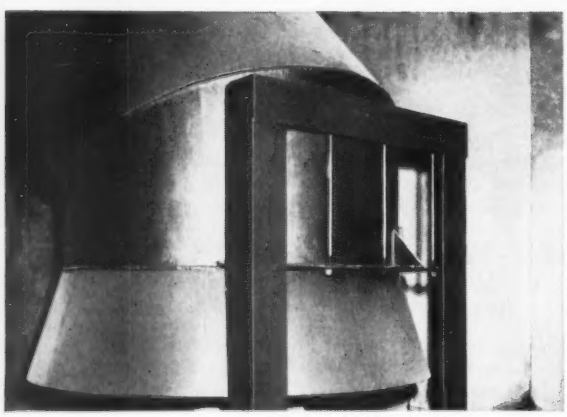
7670

MIDWEST PIPING FABRICATION AND CONSTRUCTION

Offer you many advantages

Welder applies the finishing touch to a section of corrosion resistant wrought iron duct slated for shipment to the Orlando Utilities Commission's municipal power plant.

Wrought Iron provides rugged opposition to corrosion in Orlando, Florida's municipal power plant



This wrought iron surge well outlet presents a formidable defense against corrosion and fatigue stresses at the Orlando powerhouse.

Three hundred sixty tons of durable wrought iron help minimize the threat of corrosion at the Orlando Utilities Commission's municipal power plant.

Here, ducts, tanks, pipe and stack installations of wrought iron are successfully withstanding corrosion. Result is low-cost corrosion control . . . virtually no maintenance or repairs. This material actually pays for itself in years of service rendered.

Reasons why wrought iron brings such permanence to plant facilities appear in our booklet, *The ABC's of Wrought Iron*. Write for your copy. A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.

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BYERS Wrought Iron Tubular and Hot Rolled Products

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

LOUIS N ROWLEY, EDITOR • JULY 1957 • ESTABLISHED 1882 **Power**

A spectacular future

AT TIMES during the past several months, I've wondered whether I might not wind up with a permanently split personality as a result of living almost simultaneously in the past and in the future. The reason for this double life is, of course, POWER's 75th anniversary and the research involved in preparing the special September issue that will commemorate it.

Tracing out the developments that brought into being the power world of today has taken me deep into the past for several days at a time. Between such bouts of historical research, I've been travelling about the country talking to manufacturers and consultants about the power world of tomorrow, tapping their thinking on the developments that lie ahead.

As you might expect, many of these discussions have dealt mainly with the natural extension of present clearly visible trends: How much higher can we go in steam pressure and temperature? How big can we build individual units? How fast will the atom supplement conventional fuels?

But many of our talks have been illuminated by flashes of insight into the far-reaching effects of new materials and new methods. You'll be reading more about these in September, but pause with me for a moment to speculate about the shape of things to come as it can be visualized in the labs and on the drawing boards.

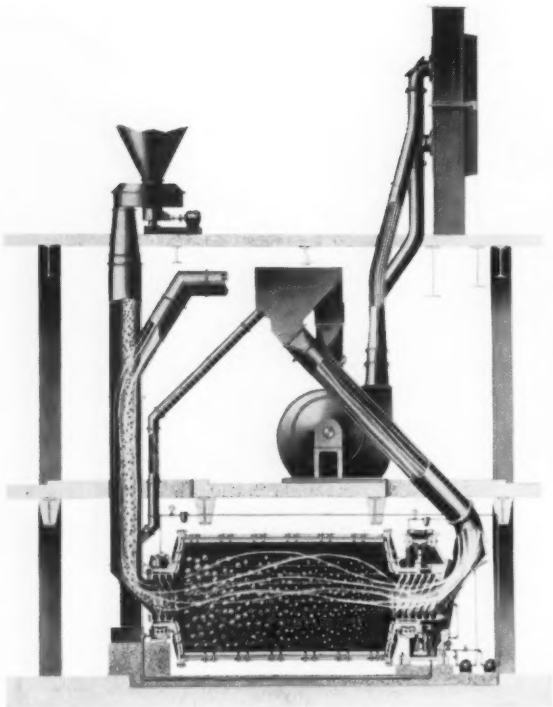
Right now, for example, manufacturers are doing some mighty interesting things with special types of glass and ceramics. Coatings that are flexible enough to yield with the steel to which they are applied give us the lined tanks and stacks we're now finding useful. But that's only a beginning. How about cooling towers of glass-coated steel, glass- or ceramic-lined engine cylinders, coated piston rings? Air-lubricated ceramic bearings have special applications today, are sure to have more in the future where conditions are tough. And many nuclear specialists believe the answer to high-temperature reactors lies in ceramic fuel elements.

Switch for a moment from new materials to new methods, and try to visualize what fast-moving computer and data-processing developments will mean to power-service control systems of the future. You may feel that automation is an overworked word and that its wonders have had more than their share of attention in the popular press. Then talk, as I did, to hardheaded specialists in the control field. You'll find that the possibilities really are enormous, that we have only begun to see the long-range changes these new technologies will bring.

These are but a few random impressions of the part of my double life that has dealt with the future. I have seen here the same vitality and imagination that gave the power field its glorious past, vitality and imagination that promise a truly spectacular future. *LNR*

KENNEDY

consider these advantages



then...decide for yourself

Large boilers should have fewer and better pulverizers. There is no reason for using more than two mills per boiler.

If your boiler burns coal at the rate of 100 tons per hour, you can pulverize this coal . . . any grade . . . with only two KVS Mills. Why use four when two will do?

Don't accept a "second best" system with high maintenance costs. Insist on a KVS Pulverized Coal Firing System for your boiler — either present or future — and gain the advantages of over-all lower maintenance costs.

COAL FIRING SYSTEM. Cutaway drawing of Kennedy Pulverized Coal Firing System showing disc feeder, pulverizer, classifier, exhauster, burner. Raw coal is delivered to disc feeder and fed into tube mill.

WE CAN SAVE YOU UP TO $3 PER

K.V.S. SYSTEM INCLUDES

- **UNBURNT CARBON LOSSES LESS THAN ½%.**
- **FULLY AIR SWEPT**
- **COAL PULVERIZED TO SUPERFINENESS**
- **COAL COMPLETELY CARBURETED**
  Ready for Combustion
- **BIG TRUNNIONS FOR AIR SWEEPING**

KENNEDY-VAN SAUN

PULVERIZERS

consider these savings

In utilizing low priced coals

In low cost maintenance

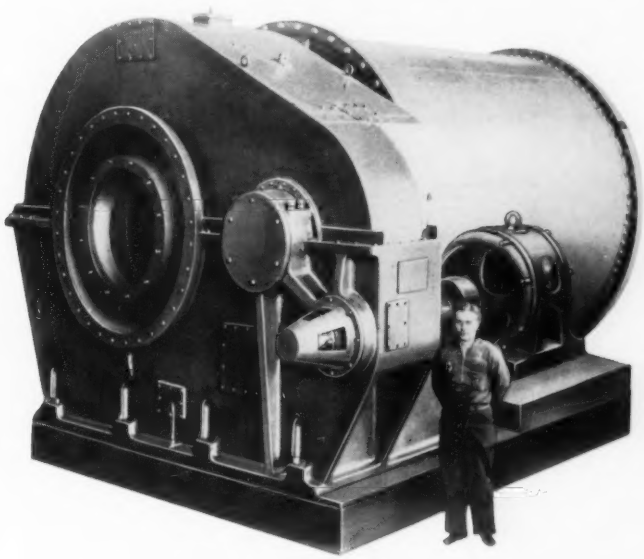
In producing superfine coal for fast combustion

In availability . . . over 99%

In increased efficiency

In maintaining a clean furnace

In reducing losses out the smoke stack



AIR SWEPT TUBE MILL. Slow-speed ball mill for perfect pulverization by air separation. Low-cost grinding of all grades of coal regardless of hardness. Grinding balls can be added without shutting down. Continuous year-to-year operation with better than 99% availability. Complete designs for steam and coal installations.

TON ON PULVERIZED COAL COSTS !

THESE EXCLUSIVE FEATURES

- BALLS ADDED WITHOUT SHUTTING DOWN
- LOW OPERATING AND MAINTENANCE COSTS
- 85% TO 90% THROUGH 200 MESH
- 20% MOISTURE REMOVED WHILE PULVERIZING
- PULVERIZES ANY COAL—BITUMINOUS, ANTHRACITE, FLUID COKE
- TRAMP IRON ACTUALLY AIDS IN PULVERIZING

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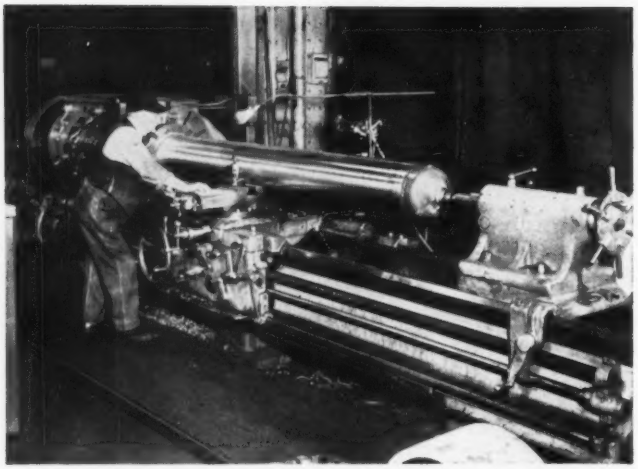
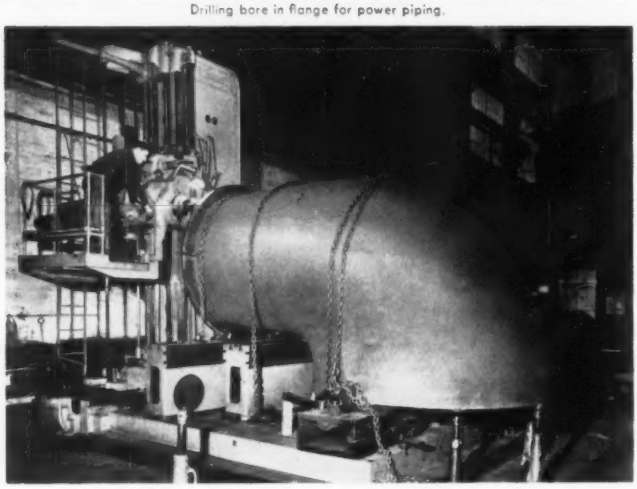


Machining stainless steel pressure vessel for nuclear installation.

Drilling bore in flange for power piping.



Drilling bolt holes in cast fitting for water service.

MACHINING at Pittsburgh Piping

another P. P. & E. service which contributes to Improved HIGH-TEMPERATURE HIGH-PRESSURE PIPING

Corrugated tangents and creased bend fabricated in Pittsburgh Piping shops. The flexibility of this type of piping is advantageous in suitable applications, making possible the use of shorter, more compact lines.

The machining of components for high-pressure, high-temperature piping, pressure vessels, and related equipment requires special skills and specialized equipment. Pittsburgh Piping has the trained, long-experienced machine operators and the proper equipment for this work. Machining is an important phase of our complete service in the shop fabrication and field erection of piping systems for central stations, processing plants, and nuclear power installations.

PRODUCTS AND SERVICES

Carbon Steel Piping	Forged Piping Materials
Cast Iron Fittings	Headers
Cast Steel Fittings	Manifolds
Chrome-Moly Piping	Pipe Bends
Copper Piping	Stainless Steel Piping
Corrugated Piping	Van Stoning
Creased Bends	Welded Assemblies
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PP-22

B G A SKROTZKI
Associate Editor in Charge

Germanium Rectifiers: the sky's the limit

By paralleling germanium cells you can get *any* amperage load. Example: new chlorine line gives 140,000 amps at 250 volts

By L W BURTON and J R THURELL, *General Electric Co*

► It's ESTIMATED that from 20 to 25% of the alternating-current power generated in the United States is converted to direct-current power before it is consumed. Developments of recent years have propelled germanium rectifiers into leading contenders for the conversion job. The list of applications requiring direct current is long and still growing. Industrial applications with large dc power requirements include:

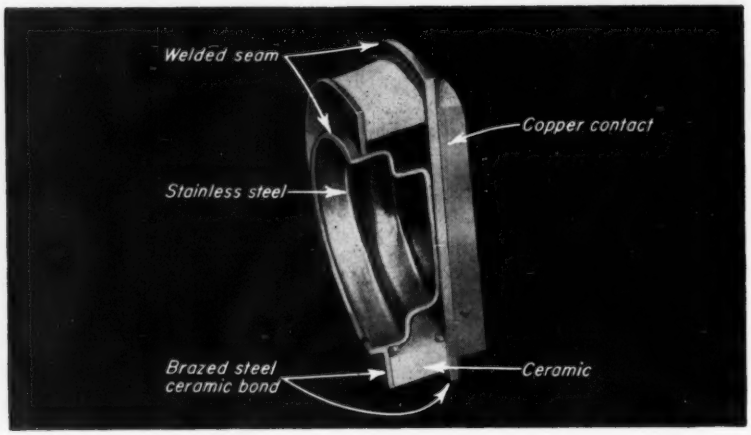
1. Metal production and refining. Aluminum depends on dc for extraction and many metals are electrolytically refined.
2. Electrochemical processes for generation of gases, such as chlorine, oxygen and hydrogen.
3. Electroplating and anodizing processes.
4. Variable-speed dc motor drives.
5. Traction motors, in such applications as mining.
6. Battery charging.

Methods of conversion vary, and each has characteristics that recommend it for a particular job (Refer to POWER, May 1957, pp 134, 135). Semiconductor (metallic) rectifiers, rotating machinery, such as motor-generator sets and rotary converters, mercury-arc rectifiers, hot-cathode rectifiers and mechanical rectifiers, are the major groups.

Germanium rectifiers belong in the semiconductor or metallic group. For the last 10 to 15 years, selenium rectifiers have been the most important of the semiconductor types from the standpoints of quantities manufactured and range of ratings available. Their advantages and limitations are well known, both by equipment manufacturers and by users. Since the germanium rectifier is a newcomer with characteristics different from selenium, a complete development plan had to be followed to find out how to apply and design equipment for its characteristics. Background experience obtained with selenium and other types of rectifiers helped in learning how to apply germanium rectifiers. By comparing germanium rectifiers with selenium, operation of the germanium rectifier can be more easily understood and evaluated.

Rectifying areas of the selenium rectifier are large and operate at low current densities, such as 0.3 amp per sq in. This necessitates use of large cell areas or stack assemblies to provide for large power supplies. The large area, however, provides a simple means of dissipating heat where it is generated. In other words, the whole rectifying area also acts as a heat dissipating area. It provides a large heat sink or thermal capacity to take care of sudden current surges or short-time overloads. So, with selenium, we have a rectifying device of large area, low current density, with well-established operating characteristics.

Now let's look at the physical construction of the ger-



TYPICAL GERMANIUM CELL has ceramic and stainless-steel construction to protect rectifier surfaces. The cells can be connected in series and parallel banks

Hermetically sealed germanium cells have long life, high

manium cell in order to better appreciate the contrast between it and the selenium cell. This germanium cell consists of a small wafer of extremely pure single-crystal germanium which is sandwiched between two electrodes. Germanium is soldered to electrodes with specially selected solders in order to accomplish rectification. One of the solders commonly used is indium. Actual size of the cell varies depending on the application, but wafer sizes normally used for power applications are about 0.020-in. thick, and from ½ to 1-in. diameter.

Actual rectifying junction is an extremely thin section through the cell. It was found that the outside edge where it is exposed can easily become contaminated and change the characteristic of the cell or cause cell failure. For that reason, a method of hermetically sealing the cell was developed, using a welded stainless-steel ceramic construction. This construction assures that the same characteristics, which cannot be changed by physical contamination, will be maintained over a long operating life. Typical hermetically sealed germanium rectifier cell is shown in photo, above.

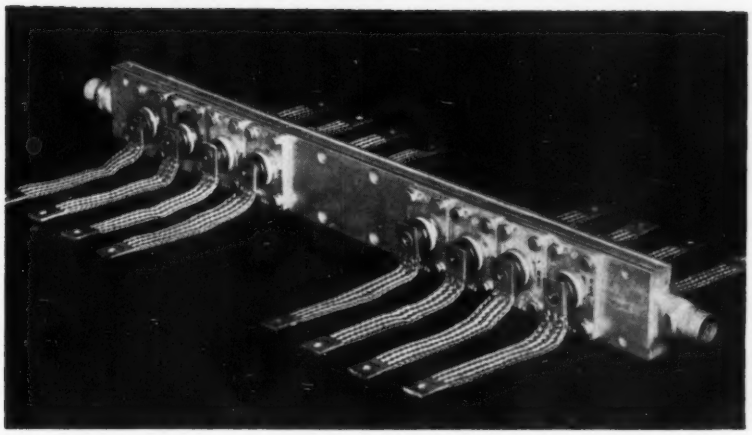
This type germanium cell operates at several hundred amp per sq in. current density as compared with the 0.3 amp per sq in. for the selenium cell. However, it is much more efficient than the selenium cell, which means less total heat loss to dissipate. (But still a large amount on a unit-area basis.)

From this description, it can be seen that one of the problems in the design of germanium cells and their application to electrical circuits is dissipating heat from the rectifying area. Various methods of cooling have been used, such as forced-air or liquid cooling. Liquid cooling has taken two forms. In one arrangement, only the heat dissipating fins are immersed in the cooling agent, such as water, and the heat is removed from one side of the cell or stack assembly, see photo, p 75. The other arrangement is one in which the cell and the heat dissipating fins are immersed in a liquid dielectric cooling agent such as perchlorethylene. Coolant is circulated past the entire stack assembly and on through a heat exchanger. All of these methods of cooling are quite satisfactory for steady state conditions where a proper balance is obtained between the losses of the cell, radiating fins and cooling medium. There is, however, the problem of absorbing high losses for a short length of time as would be experienced in current surges or short-time overloads. This can be helped to some extent by a large mass of copper or heat sink in direct contact with the cell. However, there is a limit to the heat that can be dissipated over a time basis, so it is necessary to apply current-limiting devices or protective devices in the circuit of the cell.

Let's compare the electrical characteristics of germanium and selenium rectifiers. For this comparison, a 3-phase full-wave bridge combination was selected using selenium and germanium stacks which would be rated to give a dc output of 65 v at 250 amp. In this case only a single germanium cell assembly or stack is required in each leg, while both series and parallel selenium cells are required to provide the same output. Typical dynamic characteristics of this comparison are shown in graph, p 75. It can be seen that at the rated output current for this assembly, selenium stacks have about four times the forward voltage drop of the germanium stacks. In addition, at rated voltage the selenium stacks have about three times the reverse current of the germanium stacks. The low forward voltage drop of the germanium stacks, coupled with their low reverse current, result in very high conversion efficiencies.

Efficiencies of germanium and selenium rectifier stacks are compared in graphs on p 76. For this 3-phase bridge circuit, efficiency of the germanium stacks at rated output current and voltage is about 98%. Overall efficiency of a typical unit, including losses of transformers, controls and cooling system will be between 93 and 95%, depending on design of individual components. Under these same conditions, efficiency of the equivalent group of selenium stacks is 86%, with an overall equipment efficiency of about 83%. This is a significant advantage for germanium.

In addition, the low forward voltage drop of the germanium stacks provides excellent voltage regulation. Voltage regulation of germanium and selenium rectifier stacks is compared in graph on p 76. For this 3-phase bridge circuit, regulation of germanium stacks is about 5%, whereas about



CELL ASSEMBLIES mounted on silver-plated tubular extruded aluminum section. Tube conducts both current and cooling water. Other forced-cooling methods may be used

efficiency, good regulation and high reverse resistance

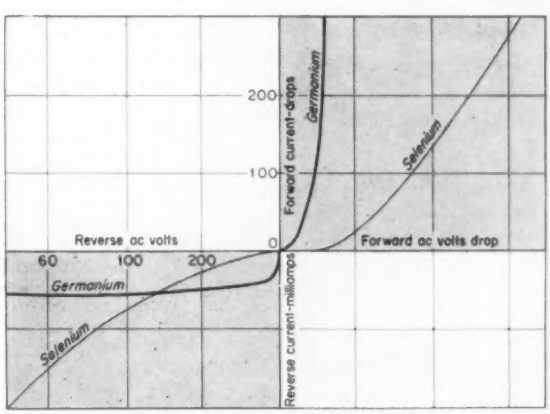
12% is obtained from the selenium stacks used in same test.

Life expectancy and aging of these two rectifiers are significantly different. Selenium rectifier power equipments have usually been designed for 20,000 to 50,000 or 60,000 operating hours of life at rated output, depending on the application requirements and current density selected. At end of this time, forward resistance of selenium stacks will have increased by about 100%. During this time, the taps on the transformer will have been periodically adjusted to maintain rated output voltage. With germanium, there is no appreciable change in the rectifier stack forward voltage drop with time. This absence of any appreciable aging assures high efficiency and excellent voltage regulation throughout the life of the equipment. It might also be pointed out that since the germanium cell is hermetically sealed and cannot be attacked from outside contaminants, there seems to be no predictable end to the useful life of the germanium rectifier.

We have discussed the current characteristics of the cells, but let's also look at their voltage characteristics or ability to satisfactorily block the reverse voltage which it may see from time to time. At time they are tested, the rectifier cells are assigned certain voltage ratings on the basis of leakage current and peak inverse volts (PIV). Adequate safety provisions are then applied for an operating rating of the cell. However, there are other considerations such as voltage transients which appear on the line and in the rectifier circuit as a result of switching, that is, when circuits are energized or interrupted. A selenium cell has a self-healing voltage breakdown characteristic. When the cell is exposed to a voltage large enough to cause a dielectric breakdown, it sparks and clears itself at this spot. A germanium cell, on the other hand, will short out and fail when it has a dielectric breakdown.

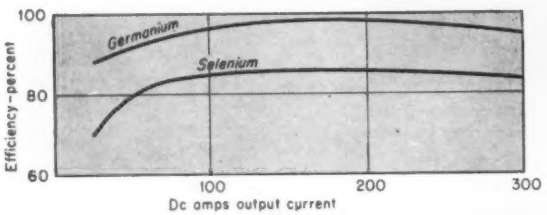
Voltage transients which were not large enough to be of importance in the application of selenium rectifiers have now become very important in the application of germanium. In order to reduce the magnitude of transient voltages, germanium equipments often use capacitors connected across the secondary of the transformer or thyrite connected across the output. These transients can be of quite high magnitude, but of comparatively small energy content, so that capacitors are capable of absorbing this energy. Temperature limitations of the two types of rectifiers make another interesting comparison. Germanium is quite critical in regard to operating temperature. Based on today's knowledge, power germanium rectifiers must be operated so junction temperature of the cell does not exceed 65 to 85 C. Higher temperatures can destroy the cell by lowering the peak inverse voltage which the cell can satisfactorily block. Selenium rectifiers, on the other hand, can operate at much higher junction temperatures, although their life expectancy decreases as their operating junction temperature increases.

Small size of the germanium rectifier is an important advantage in equipment design, but, as has been mentioned previously, it also carries a disadvantage in terms of low thermal capacity. This shows up on overloads caused by internal faults or external short circuits. Fault or overload

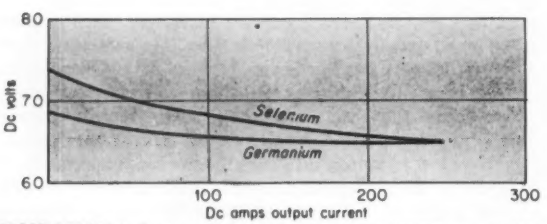


DYNAMIC CHARACTERISTICS of germanium and selenium cells in 3-phase full-wave bridge rectifier rated 250 amp, 65 v

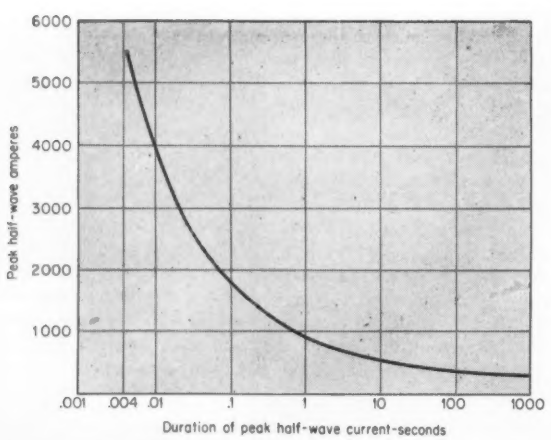
Temperature-critical cells need reliable cooling



EFFICIENCY in 3-phase full-wave bridge rated 250 amp at 65 v



REGULATION in 3-phase full-wave bridge rated 250 amp at 65 v



OVERLOAD CURRENT characteristics of germanium cell. Short duration overload currents can be large without harming cell

capabilities of the cell and cell assembly can be accurately calculated and calculations verified by precision laboratory tests. These values will vary with cell size, shape and materials. When the assembly is designed to give maximum heat transfer, cell characteristics of current vs time for peak currents of short duration will be similar to that shown at left. The cell here would have a normal continuous rating of about 250-amp peak when measured on a sinusoidal 60-cycle power supply. This cell, however, could carry up to 900-amp peak for one second or 2500-amp peak for 0.04 sec.

Limited thermal capacity of the germanium cell then brings up the problem of proper cell protection. It's obvious that standard fuses or circuit breakers operate far too slowly to protect the cells. Also, if a circuit breaker is used with a group of cells operating in parallel and one cell should fail (short circuit), the other branches would start feeding short-circuit current through the cell that failed. Resulting overloads would cause other cells to fail before standard fuses or circuit breakers could clear the fault. This could lead to the failure of as many as half of the cells in the circuit.

Selenium cells, on the other hand, with their large rectifying area and low current density provide a simple means of dissipating the heat right where it is generated. The metal base plate provides a large heat sink to take care of sudden current surges or short-circuit overload. This means that for germanium applications the protective system must be much faster in action than is needed for a similar selenium application.

Advantages and limitations of germanium rectifiers can be listed as follows:

Advantages	*Limitations*
High operating efficiency	Low thermal capacity
Very good regulation	Critical operating temperature
Small size	Susceptibility to current surges
Low forward resistance	Susceptibility to voltage surges
High reverse resistance	

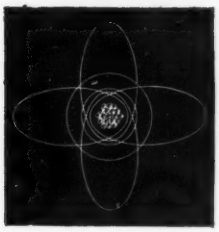
It's important to realize, these are only limitations from the standpoint that they must be carefully factored into the overall equipment design. Advantages of germanium rectifiers completely outweigh these limitations.

Germanium rectifiers have been applied to the majority of applications requiring dc power. However, main field of application for germanium seems to be in electrochemical processes: the generation of gas, refining of metals electroplating and anodizing. Germanium rectifiers have met a need in these fields where comparatively low voltage at high current outputs, with high operating efficiencies, are required.

Majority of these applications do not exceed 65-v output so a single cell in series was satisfactory with large groups in parallel for high current. One such installation for anodizing delivered a total of 40,000 amp at 24 v. Other installations for producing gas have supplied power at 65 v and 30,000 amp. On the other hand, smaller units for standard job-shop electroplating should not be overlooked. Units delivering voltages as low as 6 to 9 volts are being marketed, competitive in price with similarly rated selenium units.

Immediate trend indicates much larger equipment and many more installations in these fields where germanium rectifiers have already proven satisfactory over the past 3 or 4 years of service. There will also be a definite trend in higher voltage units using cells in series to deliver from 250 to 500 volts. One such installation is now being manufactured to supply power to a chlorine line that will require 140,000 amp at 250 v.

The next few years are going to see (1) tremendous increases in the number and size of germanium power installations (2) the development of new fields of application.



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Uranium ores of Blind River Area of Ontario are most important potential source of thorium in North America. Beds have about one part thorium to two parts uranium. If this area produces 10,000 tons U_3O_8 annually by 1959, it could also yield about 5,000 tons ThO_2; this is about 10 times present world production. AEC's modest needs for thorium in present research program will be filled by end of 1957. Thorium metal now costs $43 per kilogram; in comparison, normal uranium metal costs $40 per kilogram.

Plutonium prices to be paid between now and June 30, 1963 were announced by AEC. Up to July 1, 1962 price will range from $30 to $45 per gram depending on the Pu-240 content of the material. During the succeeding 12 months, the price will be a flat $30 per gram—these prices are guaranteed.

Isotope applications in industry make money. In 1953 about $100 million was saved, in 1956 about $390 million was estimated. Using isotopes in thickness gages saves about $110 million annually and the market is only about 10% saturated. Stimulating oil-well yields has saved about $168 million yearly. Over 1500 industrial firms find use for radioactive isotopes.

Florida Nuclear Power Group including Florida Power Corp, Florida Power and Light Co and Tampa Electric Co, proposed to AEC to develop, design and build a nuclear power plant burning natural uranium. The heavy-water moderated, gas-cooled reactor will generate 136 electrical mw and cost about $40 million. General Nuclear Engineering Corporation, headed by W H Zinn, will carry out design, research and development, including development of fuel elements.

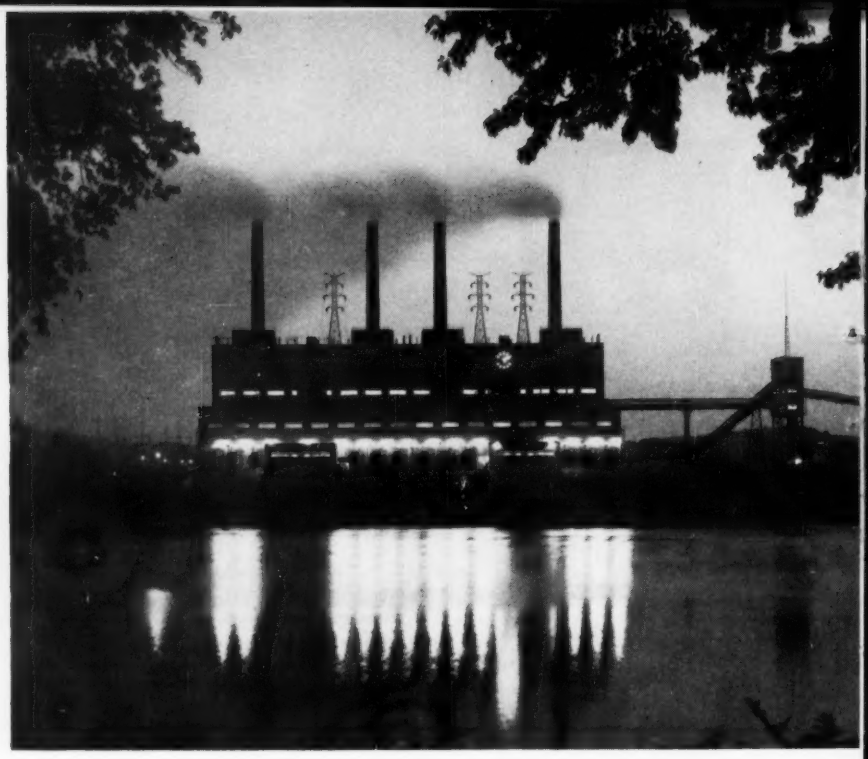
New suggested uses for radioactive isotopes include: control of soldered joints in electronic equipment, control of plywood bonding, mixing of color in textile printing, mixing uniformity of greases or paints, control of sulfur in blast furnaces producing iron.

Final figures for first fueling of U.S. Navy submarine *Nautilus* showed it steamed a total of 69,138 miles during 26 months. She has now been refueled.

Pressure testing of the container for the Army Package Power Reactor hydrostatically required building a foundation about three times heavier than needed by the equipment. This was preferred to compressed air testing because of the potential danger of releasing stored energy during possible rupturing.

Cleanliness is next to godliness—is more than a proverb in practical nuclear power plant construction. Designers find specifications for "surgical" cleanliness in nuclear reactors is the most difficult one to get across to construction workers. To avoid later radioactivity headaches and maintain close clearances, clean equipment from construction to transportation to installation to startup must be everybody's concern with no slipshod attitude being tolerated.

World's largest particle accelerator will be the Brookhaven 30-billion electron volt synchrotron, scheduled for operation in 1960. This will recapture the lead for the USA from Russia which now has a 9-billion ev accelerator. The synchrotron will have 240 magnet cores arranged in a ring 842 ft in diameter—a circumference of about one-half mile.



By **DOUGLAS HENDERSON**, *President*
Fuel Engineering Co of N. Y.

Need for the right use of the right fuel—biggest single operating expense in any steam plant—stresses the importance of . . .

What the fuel engineer's services mean to you

Five-point program for long-term top fuel economy from your steam plant

1. Determine the fuel characteristics your plant needs to give trouble-free, economical operation
2. Choose fuel on basis of (a) required characteristics (b) available supply sources and (c) current market price
3. Use available fuel market surveys as the basis for planning expansion, modernization, replacement
4. Select steam-generating equipment that'll use the most economical fuel now available and fuel that is likely to be most economical during the plant's life.
5. Employ periodic laboratory tests of fuel for quality control and plant performance check

► TODAY'S COMPLEX, cost-conscious power-plant operation depends more and more on the know-how of power-service "specialists." Some are in the plant-employee category, some represent power-plant equipment and fuel suppliers, others operate as consultants.

Paradoxically, one of the most-needed consultants—the fuel engineer—is perhaps the least known to power-plant management at large. Interesting part is, while the advent of high-pressure high-temperature steam plant operation is relatively recent, the fuel engineer has been around for 50 years.

What is a fuel engineer? Basically, he's a graduate mechanical engineer who lives with all types of fuels from coal to black liquor and bagasse. He knows their likes and dislikes, their chemistry, performance, economics. In short, his domain encompasses the alpha and omega of fuels.

A good fuel engineer must know that sound fuel buying involves more than a knowledge of current prices. He must be well-ac- (*Continued on page* 80)

PLANT OPERATING SURVEY

FUEL ANALYSES

- Proximate -

COAL

Moisture	1.6%
Ash	9.2%
Volatile	24.0%
Sulphur	1.1%
Btu/lb	13875
Softening Temp of Ash	2700
Grindability Index	

OIL

Specific Gravity	0.9732
A. P. I.	13.9
Flash Point	215
Sulphur	3.9%
Viscosity	198
Water and Sediment	0.7%
Btu/gal	147,430

- Ultimate -

Carbon	78.4%
Hydrogen	4.6%
Sulphur	1.1%
Moisture	1.6%
Ash	9.2%
N+O	5.1%
Carbon in Refuse	15.0%

Carbon	84.2%
Hydrogen	10.2%
Sulphur	3.9%

GAS

CH4 - 83.4% CO2 - 0.2%
C2H6 - 8.7% O2 - 0.6%
C3H8 - 3.0% N2 - 4.1%
Btu/cf - 1018

AVERAGE OBSERVATIONS

Boiler Designation or type of fuel used	COAL	OIL	GAS
Steam pressure, psi	125	125	125
Steam temperature, °F	Sat.	Sat.	Sat.
Feed water temperature, °F	212	212	212
Flue gas temperature at boiler exit, °F	500	500	500
Flue gas temperature at economizer exit, °F	—	—	—
Flue gas temperature at air heater exit, °F	—	—	—
Percent CO2 at boiler exit	13.0	13.0	10.0
Steam generated, lbs/hr	30,000	30,000	30,000
Fuel consumed, lbs/hr	2,755	—	—
" " gal/hr	—	255	—
" " mcf/hr	—	—	39.0

HEAT BALANCES

Controllable losses; dry gas	11.0%	9.2%	8.5%
ash pit refuse	1.7%	—	—
Uncontrollable losses; wet gas (M+H)	3.8%	6.2%	11.9%
Total measurable losses	16.5%	15.4%	20.4%
COMBINED EFFICIENCY	79.5%	80.6%	76.6%
Unaccounted for	4.0%	4.0%	3.0%

CALCULATIONS

Btu per pound of steam	1,013.0	1,013.0	1,013.0
Lbs steam produced per lb coal	10.89	—	—
" " " per gal oil	—	117.3	—
" " " per mcf gas	—	—	769.8
Grate area, sqft	90	—	—
Furnace volume, cuft	—	1,500	1,500
Heat release, Btu/sqft/hr	424,700	—	—
" " , Btu/cuft/hr	—	25,000	26,500

Operating survey data sheet spots weak links, shows what's needed to up fuel economy, boiler efficiency

quainted with sources of supply and long trends of consumption and costs. On the engineering side, he must know firing equipment design and application. Whether or not it's suitable to the individual plant's needs, its most efficient performance level and how it might limit fuel choice.

Fifty years ago the fuel engineer became the craftsman of a newly-created branch of technology. Traditionally, coal dominated the country's steam plant fuel economy. Early fuel engineers centered their attention on coal's physical and chemical characteristics, came up with results of an elementary examination identified as *proximate analysis*. This determined only the exact chemical makeup in percentages of moisture, volatile, sulfur, ash and Btu. Physical form in which the compounds appeared didn't matter. Later the analysis was extended to include ash-softening temperature, free-swelling index and grindability index.

All of this data is necessary for both accurate combustion calculations and evaluating coals for a plant's specific needs. Then other special-purpose tests were developed in the constant hunt for higher efficiency—size analysis, ultimate analysis (carbon, hydrogen and nitrogen) and chemical analysis of ash to determine its elemental makeup. The latter can be very important in plants where ash discharges in a molten state and slag fluidity is a factor.

The fuel engineer has come a long way from combustion equipment of fifty years ago to today's spreader stokers, pulverizers and cyclone furnaces which burn coal in competition with oil and gas fuels. And since fuel is the largest single operating expense in steam generation, today's fuel engineer must hold tight control of this item to get top economy for the plant.

Certain fuel characteristics can be combined to enable any coal-burning plant's installed equipment to meet steam demand efficiently and economically. When the range is held to narrow limits, purchasing tends to concentrate on premium coals. If allowed a broad quality range, the plant's apt to have operational headaches.

Fuel quality. In defining fuel-quality range, the fuel engineer gives the plant's management the greatest possible choice, together with trouble-free operation. To do this, he must be sure that fuel selection will stay within the range suitable for plant use and economically available on the market at all times.

It's sometimes possible to switch to a higher priced fuel and yet save money. Case-in-point is that of a small machinery manufacturer who was using a type of coal not at all suited to his combustion equipment. Boiler room personnel were dissatisfied and maintenance costs climbed. A fuel engineer was called in, surveyed the setup, discussed it with engineering and purchasing. Result was a fuel specification that upped annual fuel cost by about $5000. The company's own figures showed that the increase was more than offset by sharply reduced maintenance.

Unlike important industrial material markets, there isn't any single fuel market, but rather an intricate pattern of localized markets. Each one has its own distinctive relationship to kind of fuels economically available. Also to price and value relationship among coals, between coal and oil or oil and natural gas. These competitive relationships change from time to time within the individual sections of the fuel producing industries.

Some changes are purely transient or seasonal and need to be recognized as such. Nevertheless, they're important enough in making short or medium term fuel-buying decisions. Others are permanent or semipermanent, but subject to gradual change because technological or economic trends can, over the long term, affect production costs, prices and supplies of particular fuels.

Fuel characteristics have considerable effect on coal-burning plant operation. For example, with pulverized coal, grindability index and percent volatile can impose significant limitations. Stoker firing generally emphasizes size consist and ash content. With both, ash-softening is often a critical factor. In today's highly efficient units with their low flue-gas temperatures, adverse effects of high-sulfur content demand close consideration.

Residual fuel oil began to attract attention as an alternative steam fuel at the end of World War I. Particularly in the area east of the Mississippi and north of the Ohio and Potomac rivers—a section which had mined and used more than 90% of our coal.

Heavy fuel oil, identified as No. 6 or bunker C, was subjected to close scrutiny by the fuel engineer. Its characteristics were determined and laboratory runs came up with acceptable tests to establish grade standards for API and specific gravity, water and bottom sediment, viscosity, flash point, sulfur and Btu.

Viscosity proved to be a critical factor from use standpoint; tests quickly showing the importance of preheat temperature standards for mechanical, steam or rotary cup atomization. Carbon residue and pour-point tests of heavy grades made it plain that these characteristics couldn't be ignored. For the lighter grades, the fuel engineer learned that he must have entire distillation range data in order to get to the bottom of a firing problem involving these oils. Too, he learned that percent ash and ash analysis must be known to combat slagging and corrosion.

Refinery operations during the early oil booms in the Southwest produced a high grade residual in which sulfur content rarely topped 1½%. Aware of what the combination of high sulfur content and low-temperature flue gas can do to metal surfaces, the fuel engineer has stayed abreast of methods to combat corrosive effect as bunker C's sulfur content rose to the present 2 to 4%.

Sulfur increase is due to a couple of factors. First, the oil imported from Arabian and South American fields and, second, steadily improving refinery practices that have downgraded both yield and quality of residual. As this latter trend continues, it appears that residual may be ultimately marketed as a solid, known as fluid coke. (POWER, Dec 1955, p 102).

Fluid coke. Desirable characteristics of fluid coke as a fuel are somewhat offset by (1) its disadvantages of being difficult to pulverize, as compared to bituminous (2) need for a supplementary fuel (gas or oil) to maintain ignition temperature. Too, under present conditions, economical use of fluid coke seems possible only for plants located near the producing refinery. Transportation over any distance, using conventional equipment, would be difficult and costly compared to other fuels.

Natural gas came into the picture in the 1930's. The fuel engineer closely followed this transition and the adjustment of our three-fuel economy which has been progressing ever since. The gas became available over portions of the previously outlined areas as the first long-distance pipelines snaked their way in from the southwest. As a competitive fuel, economical use depends upon a plant's nearness to the gas fields. In general, however, when gas is transmitted over long distances its chief outlets are specialty markets, such as domestic heating and process usage.

The old adage, "one man's meat is another man's poison" can be aptly applied to power-plant fuel selection. To set a plant's feet firmly on the economical oper- (*Continued on page* 188)

For power-service management: A roundup of today's thinking on . . .

Allocating steam and electricity costs in industrial power plants

► IF YOU WERE TO ASK your top management men to name —in order of importance—the tools that are most useful in carrying out their jobs, chances are reliable operating-cost information would be near the top of the list. And if your company is a substantial user of steam and electricity, these services probably account for an important part of overall operating costs. Yet, unless your plant has set up a logical system for allocating these service costs between using departments, the information that funnels back to management may be unreliable, even misleading.

What's the problem? Plants such as public utilities, generating only electric power, have a relatively easy problem: they simply charge all the steam generated against electric power. And plant heat rate, Btu per kwhr, gives them a ready index for comparison with other plants.

Often, the problem boils down to how much heat energy should be charged against power generation. Some engineers believe that a steam turbine should be charged with the cost of all the steam that passes through it, and the exhaust or extracted steam should go to process *for free.* Others say that the turbine should be charged with the heat required for straight-condensing operation, charging the steam process with only part of the heat it actually consumes. Still others contend that a steam turbine is—for accounting purposes—solely a reducing valve and that no steam should be charged against power generation except that which is actually condensed.

The Btu system. Many of today's industrial power plants find the Btu system of allocating heat costs to power generation, a practical approach to their problem. Let's see how it works.

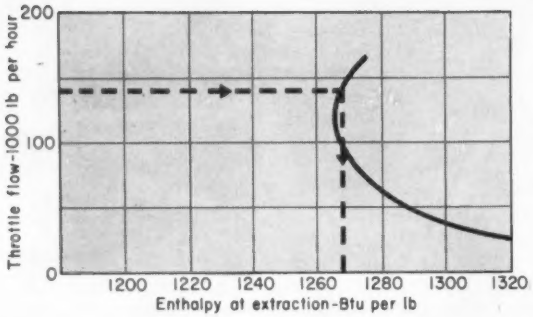
The diagram, top, p 82, right shows relative values of heat energy consumed in various parts of a condensing

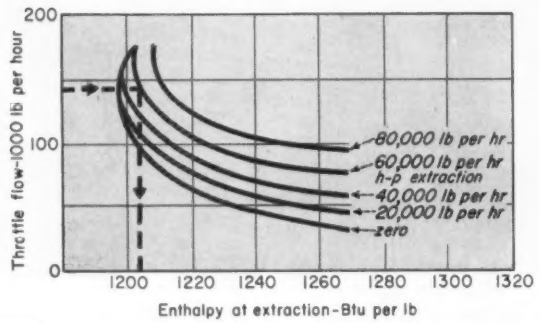
Papers on which this report is based

- **A Practical Approach to the Allocation of Heat in an Industrial Power Plant**
  Ronald J Martin, Manager of Utilities, Beaunit Mills, Inc, Elizabethton, Tenn.; ASME Paper No. 57-S-10

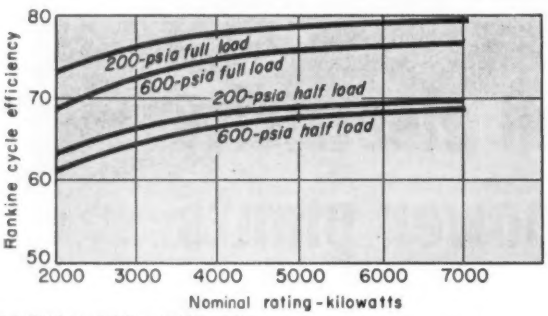
- **A System of Charging for Steam in Industrial Plants with Power Generation**
  L J Sforzini, Utilities Engineer, Consultant, and C A Winslow, Jr, Staff Ass't, Eastman Kodak Co, Rochester, N. Y.; ASME paper No. 55-A-54

- **Distribution of Steam and Electrical Power Costs in an Industrial Plant**
  Howard P Kallen, Associate Editor, POWER, *McGraw-Hill Publishing Co, N. Y., N. Y.; 1957 American Power Conference paper*

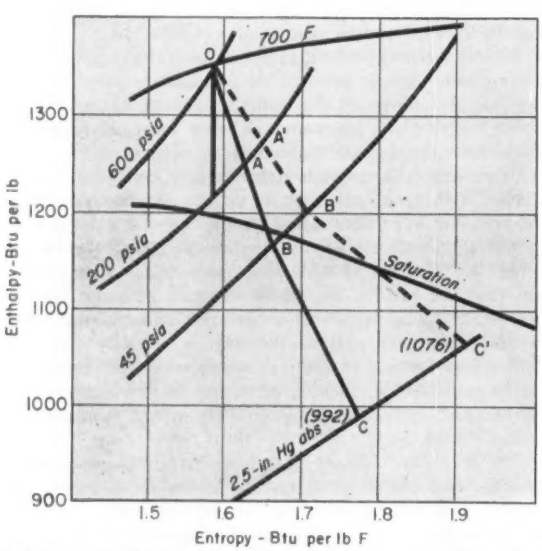




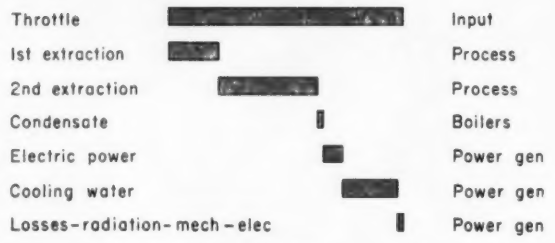
CONDENSER FACTOR figured from curves showing enthalpy of steam at extraction points vs steam flow in the turbine



RANKINE CYCLE EFFICIENCY is lower at higher initial pressures and in small machines. Curves show efficiency trend



MOLLIER CHART on which steam expansion through the turbine is plotted. Turbine makers supply data for such curves



DISTRIBUTION OF HEAT ENERGY consumption for double-extraction condensing steam turbine. Unit is 600 psia, 700 F

A cost distribution system that calls for metering only kilowatt-hours and condenser steam flow

double-extraction turbine. Such units are typical of large industrial power operations where electric power is generated and steam is needed at several pressure levels.

Heat charged to power generation is made up of: (1) radiation losses (2) friction losses (3) electrical and windage losses (4) electrical energy produced (3413 Btu per kwhr) (5) heat rejected to the condenser.

Assuming we don't recover heat in an air cooler, oil cooler or main condenser, we can charge Btu for power generation from:

$$\text{Btu} = PK_1 + WK_2$$

where P = kwhr generated; W = condenser flow, lb; K_1 = kilowatt-hour factor; K_2 = condenser factor.

If we add the losses, listed above, to 3413 Btu per kwhr we get the actual Btu needed to generate one kwhr. Turbine manufacturers supply such data. An average, without heat recovery, is 3600. With heat recovery in an oil and air cooler, 3450 is typical.

To find the condenser factor we again call on the turbine manufacturer to supply info, graphs top, at left. Curves are for a double-extraction turbine. For example, with a 140,000-lb-per-hr throttle flow, first bleed point (165 psia) is 1266 Btu per lb. Rankine cycle efficiency in this section is about 70%. Second bleed point (65 psia) is 1205 Btu per lb. Rankine cycle efficiency for second section is 80%. Graph center, at left, shows how Rankine cycle efficiency varies with pressure and turbine rating.

Referring to the Mollier chart, bottom, at left, steam expands along line OA in the first section (70% Rankine cycle efficiency) at full load. In the second section, steam expands along AB (80% efficiency). Assuming 80% efficiency from the second extraction point to the condenser, expansion is along line BC to 2.5-in. Hg absolute. Enthalpy at this point is 992 Btu per lb. Heat of the liquid at 2.5-in. Hg absolute is 76 Btu per lb. Thus, condenser factor is 992 – 76 or 916 Btu per lb rejected to cooling water. Dotted lines show the condition for 40% load.

Usually, K_2 falls between 910 and 1000 Btu per lb. Knowing load conditions we can get this figure within the accuracy limits of our meters.

In plants with only back pressure turbines or in plants where all heat is recovered in the main condensers, second term of the formula drops out.

In brief, with the Btu system we only need to know kilowatt-hours generated and condenser flow to figure heat chargeable to power generation.

BOILER PLANTS	
TOTAL ACTUALLY GENERATED	
BOILERS	1000 STD LBS
800#	446,770
260#	40,725
210#	83,532
TOTAL	571,027

USED BY STEAM POWER
1000 STD LBS
22,633

STEAM AVAILABLE FOR DISTRIBUTION	
BOILERS	NET 1000 STD LBS
800#	434,614
260#	36,719
210#	77,061
TOTAL	548,394

10TH PERIOD ENDING

ITEM	POWER SERVICES	ELECTRIC POWER	STEAM POWER	-36° REFRIG	COMPR AIR	DISTILLED WATER	TOTAL	MFG DEPTS
1	BTU EXTRACTED EXHAUSTING AT 260, 135 AND 70 LBS	14 10,412 8 13 5,909 21 2058 12 6258 22 270 11 12805 10 2899 TOTAL 40,706					40,706	STEAM DELIVERED 260# 12,471 210# 2226 135# 21320 70# 114,771 5# 116,736
2	BTU EXTRACTED EXHAUSTING AT 5 LBS	14 8308 5 1717 13 11803 1,6,9 7 12 4312 21 1081 8 — 22 602 TOTAL 27,830	AUX 800 4251 260 20 210 409 TOTAL 4680	COMPRS 1625 PUMPS 37 TOTAL 1662	KPW 602 KPE 182 25 " 384 496 TOTAL 1123	EVAPS 985 TOTAL 985	56,091	
	% OF TOTAL	49.5	8.4	3.0	2.0	1.8	100.0	UNACC'T FOR 23,171 = 4.4%
3	ADDITIONAL BTU FOR CONDENSING OPERATION & EXHAUST HEAD LOSSES PRORATED BY % IN (2)	91,116	15,462	5,522	3,691	3,314	184,073	
4	TOTAL BTU CHARGE	159,652	20,142	7,184	4,804	4,299	280,870	TOTAL 267,524

"Our Btu system provides a method of checking, controlling power - service costs"—*Sforzini, Eastman Kodak*

Steam and electricity users at Eastman-Kodak are also charged on the basis of a Btu system. The charge against any piece of steam-using equipment is for the Btu it uses. But since operators, through long accustomed use, preferred the idea of being charged for a *pound of steam*, E-K engineers set up the arbitrary term *standard pound of steam* and defined it as the addition or removal of a thousand Btu's of heat, regardless of pressure or temperature conditions.

The system applies the same cost, per Btu, to both low- and high-pressure steam users. Here's how it's justified: (1) High-pressure boilers, especially when added to a low-pressure boiler plant, usually employ larger units, resulting in lower unit cost. (2) Reliable reference sources give the difference in cost between a 150-psig saturated plant and a 600-psig 700-F plant as 50 cents per pound per hour of steam capacity. Writing this off as a 10% fixed charge rate and 50% steam plant load factor, adds only a little over one cent per 1000 pounds or per million Btu. (3) Combining steam and power production, lowers unit costs to the steam user. (4) While low-pressure steam requires larger lines and more heating surface, high pressure may call for more expensive insulation.

Steam charges. In cases where E-K sends extracted or exhaust steam to process, the steam charge for electric generation is the Btu removed from the steam passing through the turbine, plus external losses such as that from machine bearings, radiation and generator where winding heat isn't recovered.

Steam rate isn't an important factor in the Kodak system. If heat isn't converted to mechanical energy, it remains to be used in process.

The kilowatt-hour is, by definition, 3413 Btu and, allowing for 5% losses, a figure of 3600 Btu per kwhr (much like the kilowatt-hour factor we spoke about earlier) becomes the steam charge. It's not necessary to meter the steam to make the charge. All E-K really needs to meter is electrical output. But for steam balance purposes, steam is metered to all units.

Where mechanical drive turbines supply extracted or exhaust steam to the process, a charge of 2545 Btu per horsepower hour is used. External losses are considered part of

the driven load. The hphrs are based on manufacturers' guarantees modified to field conditions.

Where exhaust discharges to a lower-pressure steam system whose heat goes both to process and to the atmosphere or condenser water, Kodak adds up all hphrs and kwhrs produced from this pressure. Each of the turbines are charged with part of the cost of Btu's in the rejected steam. As Engineer Sforzini puts it: They have produced a product for which there is no market and must be penalized accordingly. By this method, the type of drive unit (motor or turbine) is installed for its effect on the plant as a whole, not for its effect on a single service.

Use of power services. Each power service is charged for the other power services it uses, at the same rate as a process department. If it uses its own product, it's charged at the full unit cost. For instance, feed-pump drives for a steam plant may be electric or steam. In either case, the steam plant is charged for so many kwhrs or standard pounds of steam at the full distributed cost. Exceptions to this rule are: (1) soot blowing (2) stoker humidification (3) blowdown heat.

Stage heaters don't use up heat. They transfer it from steam to feedwater. Thus, while this heat is considered in the steam balance, no charge is made for it.

How system is applied. The chart, previous page, shows a typical period summary sheet (four weeks). Six pressures —800, 260, 210, 135, 70 and 5 psig—and steam condensers are involved. The summary sheet is based on metering, record keeping and detailed tabulation sheets. Complete steam balance is made each period. Books are closed on a Saturday, and the following Wednesday the summary sheet has been figured, together with the quantity breakdown for the 9 services, into about 150 different accounts. Results are turned over to the accounting division.

The *Total actually generated* is the total Btu converted from fuel to steam. It's the output quantity E-K uses to figure boiler efficiency. The *Used by steam power* is for soot blowing, blowdown and stoker humidification steam. Difference between the two is *Steam available for distribution.* The block labeled *Manufacturing departments* is the sum of all metered and estimated uses for process, plus a prorated share of the *Unaccounted for.* This last item is the final difference resulting from the period steam balance. Difference between the *Steam available for distribution* and the *Manufacturing departments* is the *Total to power services.*

Item 1 of *Power services* is the 3600-Btu portion of the kilowatt hours.

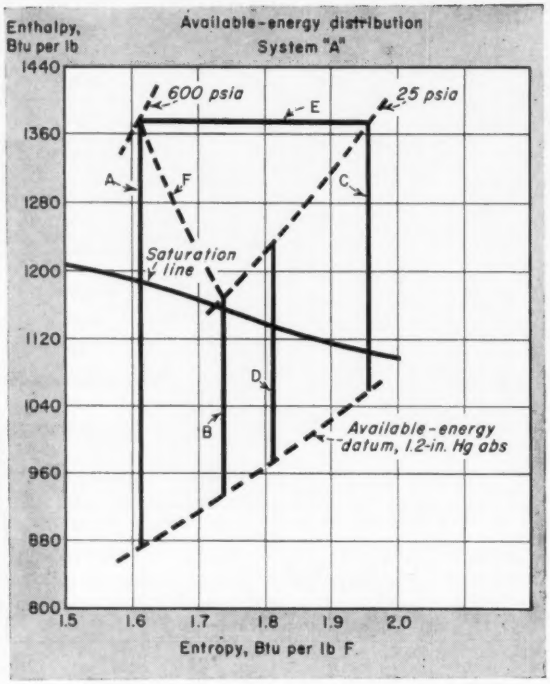
Item 2 is the kwhr and hphr equivalents of units or parts of units making or taking low pressure steam. Kodak uses the total of this item to divide the remainder of the available steam (item 3) that goes to condensers, to the atmosphere, radiation losses, line condensation and a prorated part of the *Unaccounted for.*

Item 4 is the total of the first 3.

The steam balance is a key part of the over-all procedure. The steam system is balanced both on the basis of pounds and Btu's. It also yields info on heat removed by electric generation, turbine or engine drives, etc.

Using this system, it's easy for Eastman Kodak to figure an index similar to a central station heat rate: Btu per equivalent kwhr. *Equivalent* is in the index because a substantial block of mechanical power must be considered for a true comparison with central station heat rates.

The sum of items 1 and 2 on the summary sheet divided by 3600 is the *Electric power production.* This figure, divided into item 4 is the Btu per kwhr from steam. Dividing again by boiler efficiency yields Btu per kwhr from fuel.



How should you allocate costs?—A close look at your plant's heat balance provides important clues

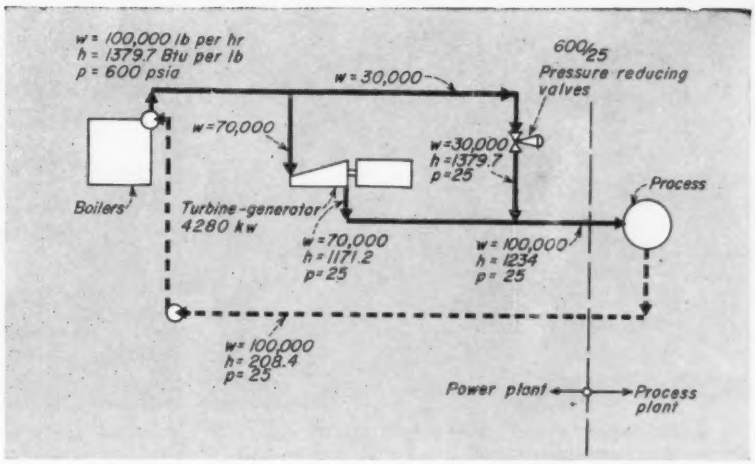
Still another approach to power-service cost allocation: Study overall plant heat balance and decide whether additional use of either steam or electricity will improve the heat balance. Armed with this info, you set up a cost distribution system that applies a relatively lower unit energy cost to the service (either steam or electricity) whose increased use results in a more economical heat balance.

By using a cost system that favors the use of one power service over another, you always have an up-to-date answer to these important questions: Shall a process be further electrified? Or, is it more economical to install additional steam-operated equipment such as process heaters, mechanical-drive turbines?

The ideal heat balance for an industrial power plant is one in which all electric generation is on a noncondensing cycle and no steam is throttled by pressure-reducing valves to supply more low-pressure process steam. Naturally, such conditions are rarely found in industry. Fluctuating steam and electrical loads almost always result in:

(1) condensing electric generation concurrently with noncondensing generation—where electrical needs are greater than can conveniently be supplied as a by-product of process steam. In this case, the cost-allocation system should encourage use of additional process steam by applying low unit charges for this service.

(2) noncondensing electric generation together with throttling high-pressure steam by pressure-reducing valves. Here, the system should encourage further use of electricity by applying low unit charges for noncondensing power.



HEAT BALANCE diagram for an industrial power plant that generates all electric power in noncondensing turbine-generators. Pressure-reducing valve, in parallel with turbine, supplies additional process steam at 25 psia

AVAILABLE ENERGY (a-e) distribution for the noncondensing power plant. Line A is a-e to the turbine, pressure-reducing valve. B is a-e leaving the turbine. C is a-e leaving the pressure reducing valve. D is a-e to the process. E is throttling in the pressure-reducing valve. F is the turbine state line

(3) operation near the cross-over point between (1) and (2). Seasonal process load variations, building heating needs, can result in an operating range that straddles the ideal heat balance.

Now let's take a close look at a system that generates electricity in a noncondensing turbine-generator in parallel with a pressure-reducing valve, diagram above. Since we are only trying to set up a logical cost-distribution method for this system, we can simplify the problem by assuming: (1) zero makeup water (2) no enthalpy drop through the pressure-reducing valve (3) no boiler heat losses (4) no heat losses or pressure drops in the piping system (5) boiler-feed pump work is negligible (6) mechanical and electrical losses in the turbine generator are negligible.

To figure available energy (the energy removed from steam in expanding it ideally through a condensing turbine), we adopt 1.2-in. Hg absolute as our reference condenser pressure. Why do we consider a *fictitious* condenser in a noncondensing plant? If the plant didn't require 25-psia steam it would have been possible to expand the turbine steam to 1.2-in. Hg absolute in a condensing turbine, generating additional power. The condensing plant represents a possible alternative to the present plant.

The ideal state line for a condensing turbine is *line A* on the Mollier chart, facing page. *Line B* is the ideal expansion of a condensing turbine that could have followed that actual noncondensing unit, if the plant didn't call for 25-psia process steam. By subtracting A – B we get the available energy used up in the noncondensing turbine.

It's an easy matter to figure available energy drops through all types of steam-using equipment. We simply plot entering and leaving available energies on a Mollier chart (after setting up a reference condenser pressure) and subtract them.

Charges to steam and electricity users based on available energy consumption, represent an alternative to the Btu system. Let's see how it would affect the system shown above.

Notice that we need a 600- to 25-pound reducing valve to supply 25-psia steam demands in excess of that supplied from the noncondensing turbine outlet. Any additional 25-psia steam must be supplied by increasing flow through the reducing valve—an inefficient process. In contrast, an increase in electrical demand could be handled by increasing flow through the noncondensing turbine, an economically desirable process. Thus, any logical cost-allocation method for this system should encourage electric power users by charging them at a relatively low rate. Next, let's decide which of the two methods, the Btu or the available-energy method, achieves this goal.

Results. Charges based on the Btu system assign 12.5% of operating costs to electric power users. Process steam users are tagged for 87.5%. Available-energy cost method bills electric power users for 39.6%, steam consumers for 60.4%.

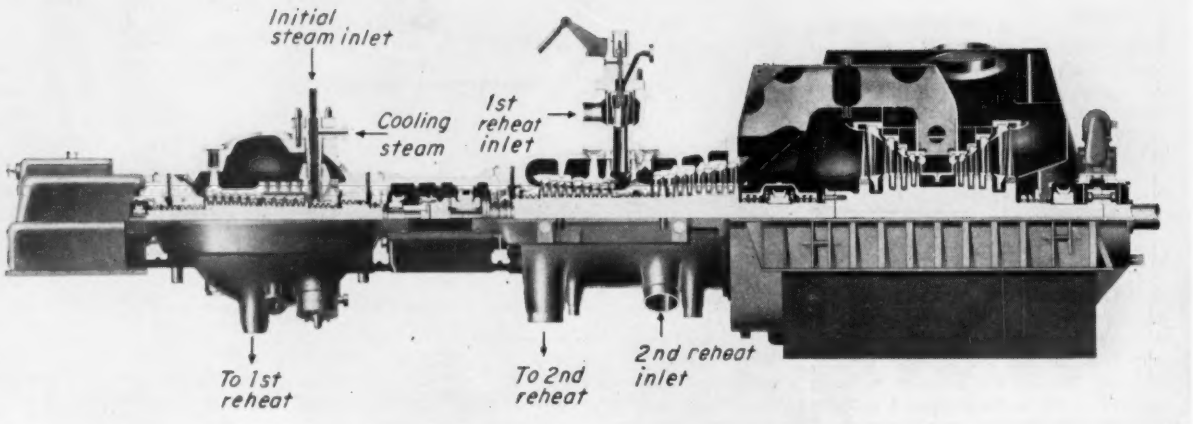
Comparison of these figures shows that available energy calculations tend to penalize electric power users—give steam users the benefit of a *bonus* rate. Btu system figuring has the reverse effect.

We've already seen that we can improve the plant heat balance by passing more steam through the noncondensing turbine, trimming down reducing-valve flow. Thus we need to increase electricity use. Logical way to allocate costs for this plant: the Btu system. And it points up an important principle: Where plants generate electric power through noncondensing turbines only, throttling steam through pressure-reducing valves, they should allocate costs on the basis of Btu drop through energy consuming equipment.

Condensing turbine-generator systems pose a somewhat different problem. Let's assume we're going to set up a cost-distribution system for a plant that generates electricity through a condensing turbine-generator in parallel with a noncondensing machine operating at 25-psia backpressure. Steam goes to process at two different pressure levels, 600 psia and 25 psia. Again, we make the same simplifying assumptions as for the system shown above, and choose 1.2-in. Hg absolute as a reference pressure for available-energy calculations.

If the process has no need for additional low-pressure steam, increased electricity demands mean passing more steam through the condensing turbine at a relatively inefficient heat rate. But if the process installs more steam using equipment (when expanding production facilities) high-pressure steam could be diverted from the condensing turbine to the noncondensing turbine. Result: A more economical plant heat balance. Thus, we want a cost-distribution system that gives low-pressure steam users the benefit of a *bonus rate*. The available energy method has this effect.

Summing up, we've seen that two basically different industrial steam and power-generation systems may require different ways of allocating costs. For each plant, there's an ideal balance between steam and electrical load. And a logical cost-distribution system to serve management's needs should encourage use of the energy form that tends to bring the industrial power plant closer to the ideal balance.



TURBINE ARRANGEMENT confines the 4500 psig 1150 F steam to separate high-pressure section. Remainder of turbine, with an opposed-flow intermediate section and double-flow low-pressure section, is conventional. High-pressure section has double casings. Thin-walled austenitic nozzle boxes are surrounded by cooling steam at first stage shell pressure

Supercritical unit goes on line

At 4500 psig, 1150 F, with double reheat, Philo No. 6 is world's first commercial power generation unit using supercritical pressure

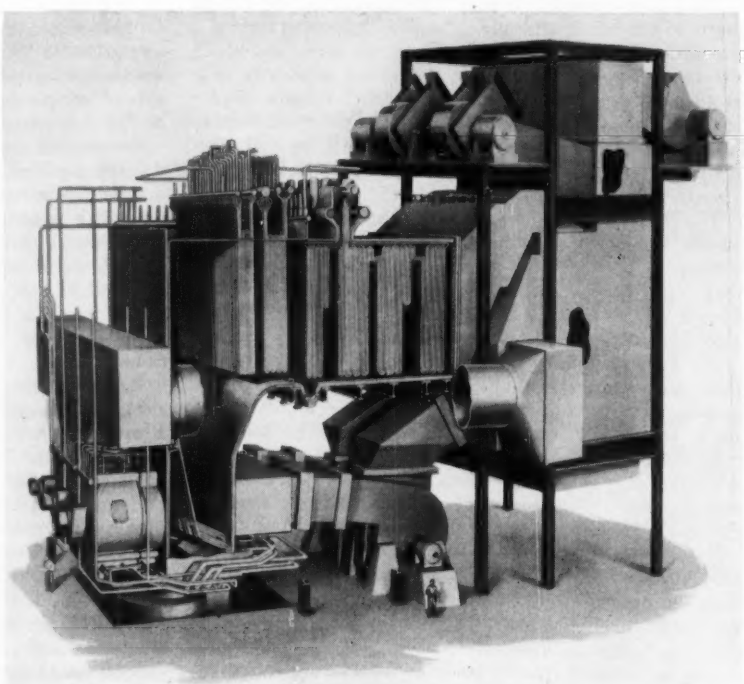
► BEGINNING OPERATION in March, 1957, the new unit at Philo plant of Ohio Power Co marked a major advance in the trend toward higher throttle steam pressures. This is the first time that a commercially practical unit has operated at a pressure higher than 3206 psia, the critical pressure of steam.

Other firsts for the unit include the first use of double reheat and the first use of steam at a temperature as high as 1150 F. This is 50 degrees above the highest temperature previously used for power generation.

Illustrations on this, and facing, page give some of the important features of the new 120,000-kw unit.

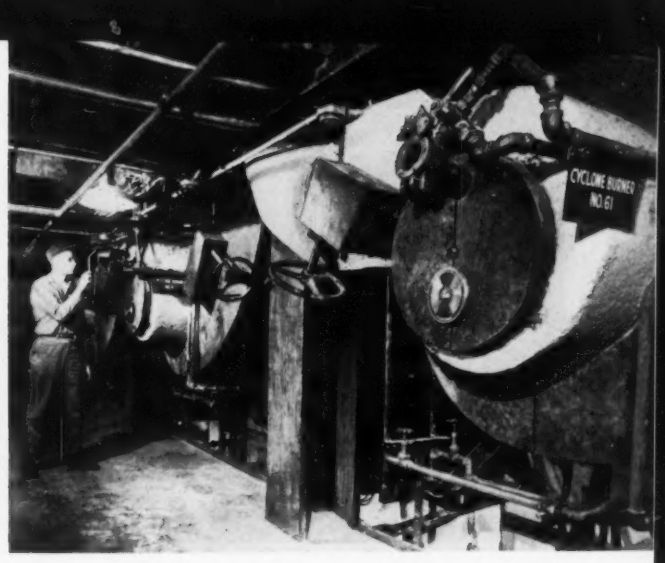
Its capacity is a compromise between the need to (1) limit size as much as possible because of the pioneering involved in any developmental machine, and (2) choose a size large enough to obtain practical experience for future units. Philo No. 6 replaces a 40,000-kw unit dating back to 1924, occupying essentially the same space.

The new unit is owned by American Gas & Electric Co, which controls Ohio Power Co. The boiler was made by The Babcock & Wilcox Co, the turbine-generator by General Electric Co and the boiler-feed pump by DeLaval Steam Turbine Co.

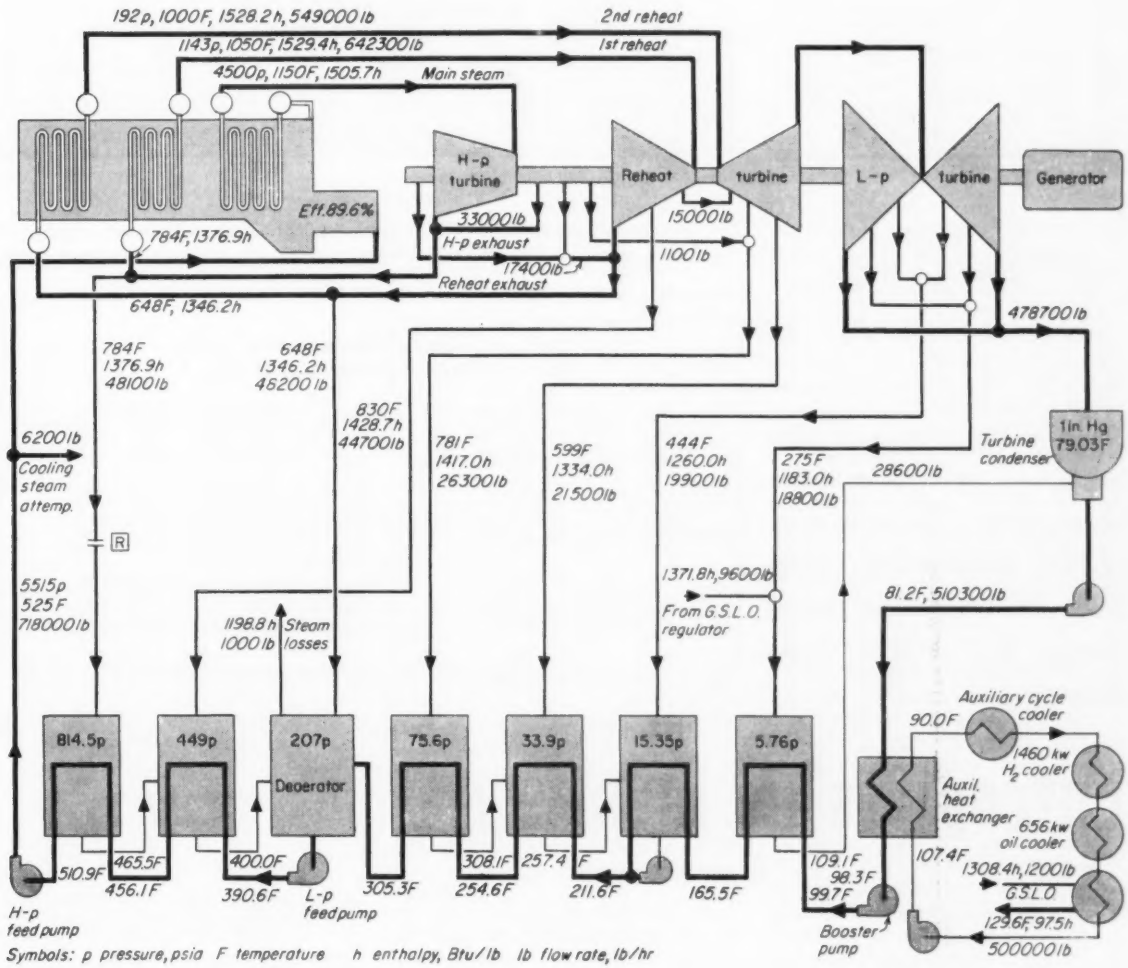


STEAM GENERATOR is rated at 675,000 lb per hr at 4500 psi and 1150 F with feedwater temperature at 525 F. The first reheat section raises steam to 1050 F, second to 1000 F. Unit is the once-through type, fired by three cyclone furnaces

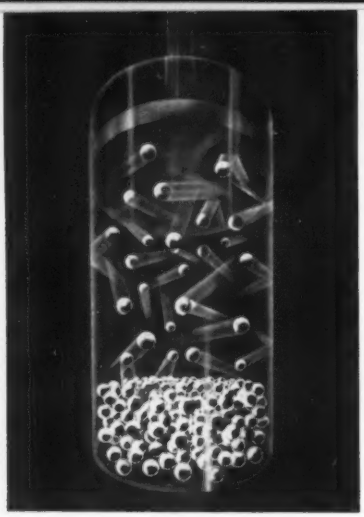
HIGH-PRESSURE austenitic rotor during inspection. This rotor is designed for shell cooling only. An alternate, ferritic rotor will use shell cooling plus rotor cooling on the first few stages

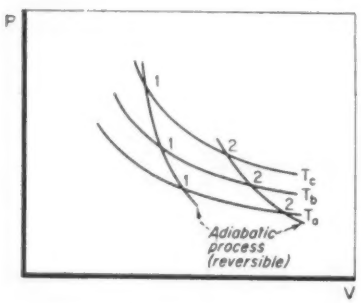


CYCLONE FURNACES burn 950 tons a day of crushed coal, converting about 90% of the ash to molten slag. Primary air at 685 F carries coal through the crusher into the cyclone

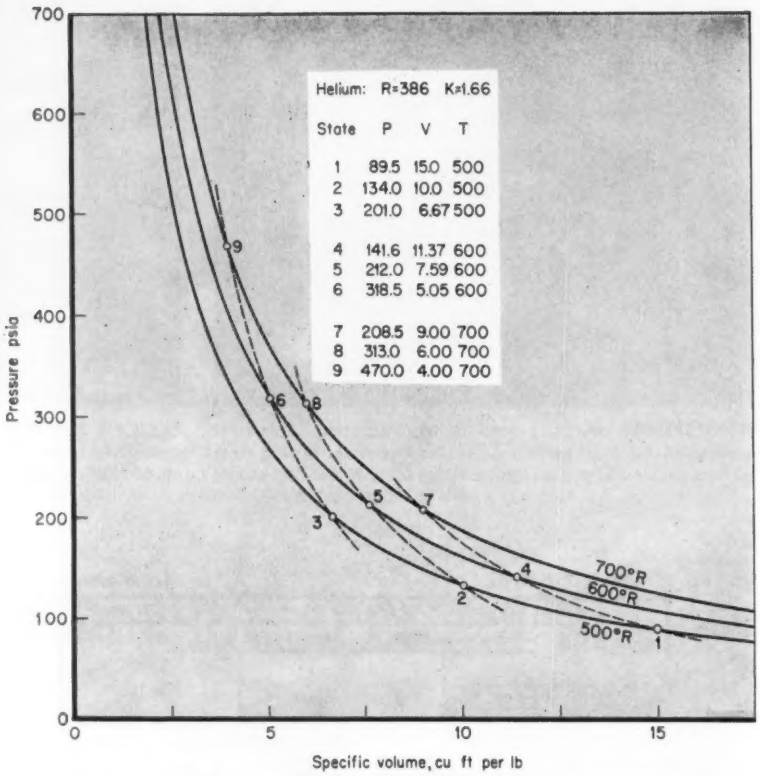


FULL-LOAD heat balance shows net plant heat rate of 8530 Btu per kwhr at 127,600 kw gross, 118,160 kw net generation. Feedwater temperature to the boiler is limited to 525 F at 5500 psi. Conventional heater designs could not be adapted for this high pressure, hence the arrangement with two boiler-feed pumps. The high-pressure heaters operate at 2100 psi





1 Constant-*T* processes bounded by a pair of adiabatics are related



2 With three constant-*T* curves and three adiabatics we can make up any number of Carnot cycles. Their thermal efficiency depends only on the temperature limits

Table 1: Heat Transfers and works for constant-*T* processes of Fig. 2

$Q_{21} = W_{21} = 100.6$ Btu	$Q_{21}/T_a = 100.6/500 = 0.2012 = S_{21}$
$Q_{54} = W_{54} = 120.7$ Btu	$Q_{54}/T_b = 120.7/600 = 0.2012 = S_{54}$
$Q_{87} = W_{87} = 140.8$ Btu	$Q_{87}/T_c = 140.8/700 = 0.2012 = S_{87}$
$Q_{31} = W_{31} = 201.2$ Btu	$Q_{31}/T_a = 201.2/500 = 0.4024 = S_{31}$
$Q_{64} = W_{64} = 241.4$ Btu	$Q_{64}/T_b = 241.4/600 = 0.4024 = S_{64}$
$Q_{97} = W_{97} = 281.6$ Btu	$Q_{97}/T_c = 281.6/700 = 0.4024 = S_{97}$
$Q_{32} = W_{32} = 100.6$ Btu	$Q_{32}/T_a = 100.6/500 = 0.2012 = S_{32}$
$Q_{65} = W_{65} = 120.7$ Btu	$Q_{65}/T_b = 120.7/600 = 0.2012 = S_{65}$
$Q_{98} = W_{98} = 140.8$ Btu	$Q_{98}/T_c = 140.8/700 = 0.2012 = S_{98}$

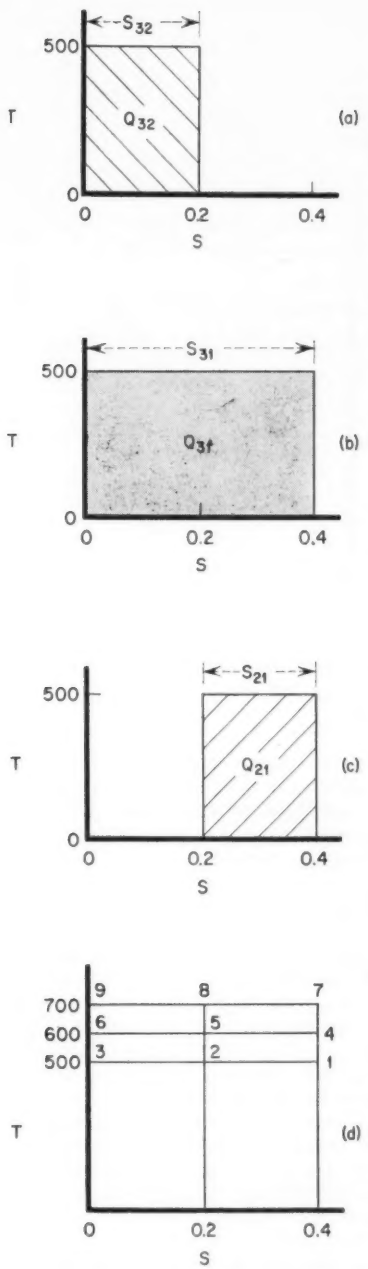
Things or ideas that we can't touch, see, smell or measure usually seem to have an aura of the supernatural about them. There's such an idea in thermo, but a little study shows . . .

Entropy is no mystery

By B G A SKROTZKI
Associate Editor

► IN OUR STUDY of the Carnot cycle last month we learned a very important fact—thermal efficiency of a heat engine depends only on the absolute temperatures of the source and receiver. The higher the source temperature, or the lower the receiver temperature, the greater the thermal efficiency of the cycle. Thermal efficiency of a heat engine is completely independent of the pressure of the gas (working fluid); we'll look into this in more detail in the next article.

Second law. A fact of even more fundamental importance that we learned, was that even in an ideal cycle, such as the Carnot, it was impossible to convert *all* of the energy received *as heat* from the source into mechanical work. Invariably, we have to reject some of that energy as heat to a receiver at a lower temperature than the source. The part of the heat that was converted into mechanical work is *available energy;*



3 Areas on T-S graphs measure only the heat transferred during the process

the remainder of the heat that had to be rejected to the receiver is *unavailable energy.*

This fact's importance is recognized by stating it as the *Second law of thermodynamics: All energy received as heat by a heat-engine cycle cannot be converted into mechanical work.*

There is one condition under which all the heat energy from a source could theoretically be converted to mechanical work. Remembering, that for the Carnot cycle, $e_t = (T_a - T_r)/T_a$ we can see that if T_r is zero, then the thermal efficiency becomes 100%. But we haven't any natural region or receiver at this temperature handy, so for practical purposes we can accept the Second law as a fact.

It has often been proposed that we should refrigerate the receiver to lower its temperature and raise the engine thermal efficiency. But we'll find that the additional work obtained must all be used to lower the receiver temperature below the atmospheric temperature; so the net gain becomes zero. This holds for ideal reversible processes. Practically, there would be an overall loss because actual processes are not reversible. In the next article we'll study the reversed Carnot cycle as applied to refrigeration.

Carnot cycle review. This cycle is so important to understanding thermo that it will pay us to review it again from a slightly different angle. Fig. 1 shows three constant-T curves, T_a, T_b and T_c crossed by two reversible adiabatic process curves. Don't forget that the mechanical work areas under any reversible adiabatic process curves are always the same between two given temperature levels, regardless of the pressure or specific volume of the gas. You should thoroughly understand this by now because for this process $W = \Delta E = c_v (T_2 - T_1)$, in other words, the work depends only on the temperature difference for the process, since $Q = 0$.

Now let's turn to the constant-T process, three are shown on Fig. 1. Remembering that the universal gas equation $P_1V_1 = RT_1$ always holds we can see that:

$$Q = W = P_1V_1 \log_e \frac{P_1}{P_2} = RT_1 \log_e \frac{P_1}{P_2}$$

$$= RT_1 \log_e \frac{V_2}{V_1} \qquad (A)$$

where the process starts and stops at any two states *1* and *2*.

Now in a Carnot cycle, pairs of states *1* and *2* can be related at any number of temperature levels by pairs of reversible adiabatic curves as in Fig. 1. The states along a reversible adiabatic are related by:

$$PV^k = \frac{RT}{V} V^k = RTV^{k-1}$$

Then we can write these relations:

$$T_aV_{1a}^{k-1} = T_bV_{1b}^{k-1}$$
$$T_aV_{2a}^{k-1} = T_bV_{2b}^{k-1}$$

Transposing these two equations we find:

$$\frac{T_a}{T_b} = \left(\frac{V_{1b}}{V_{1a}}\right)^{k-1} = \left(\frac{V_{2b}}{V_{2a}}\right)^{k-1}$$

This means that:

$$\frac{V_{1b}}{V_{1a}} = \frac{V_{2b}}{V_{2a}}$$

Transposing this equation we find:

$$\frac{V_{2a}}{V_{1a}} = \frac{V_{2b}}{V_{1b}} = \frac{V_{2c}}{V_{1c}} = V_r$$

This shows that the volume ratios V_r are equal for all constant-T processes bound by a common pair of reversible adiabatic processes as in Fig. 1. Applying the heat equation (A) we get

$$Q_a = RT_a \log_e (V_{2a}/V_{1a}) = RT_a \log_e V_r$$
$$Q_b = RT_b \log_e (V_{2b}/V_{1b}) = RT_b \log_e V_r$$
$$Q_c = RT_c \log_e (V_{2c}/V_{1c}) = RT_c \log_e V_r$$

Since $R \log_e V_r$ is a constant, C, we can write the general relation:

$$Q = CT$$

Choosing any cycle at random, say between temperatures T_a and T_b, the thermal efficiency would be:

$$e_t = \frac{W}{Q_b} = \frac{Q_b - Q_a}{Q_b} = \frac{CT_b - CT_a}{CT_b}$$
$$= \frac{T_b - T_a}{T_b}$$

This again brings us to the conclusion that the thermal efficiency of an ideal heat-engine cycle depends only on the temperatures of source and receiver.

Entropy. Now we're ready to find another property of gases and vapors that proves helpful in analyzing engine cycles. To understand it, let's start with a heat engine using helium as the working fluid (we could use any gas). Fig. 2 shows the constant-T curves for 500, 600 and 700 °R. Three reversible adiabatic curves *1-4-7*, *2-5-8* and *3-6-9* cross the constant-T curves at nine state points which are listed in the table of Fig. 2.

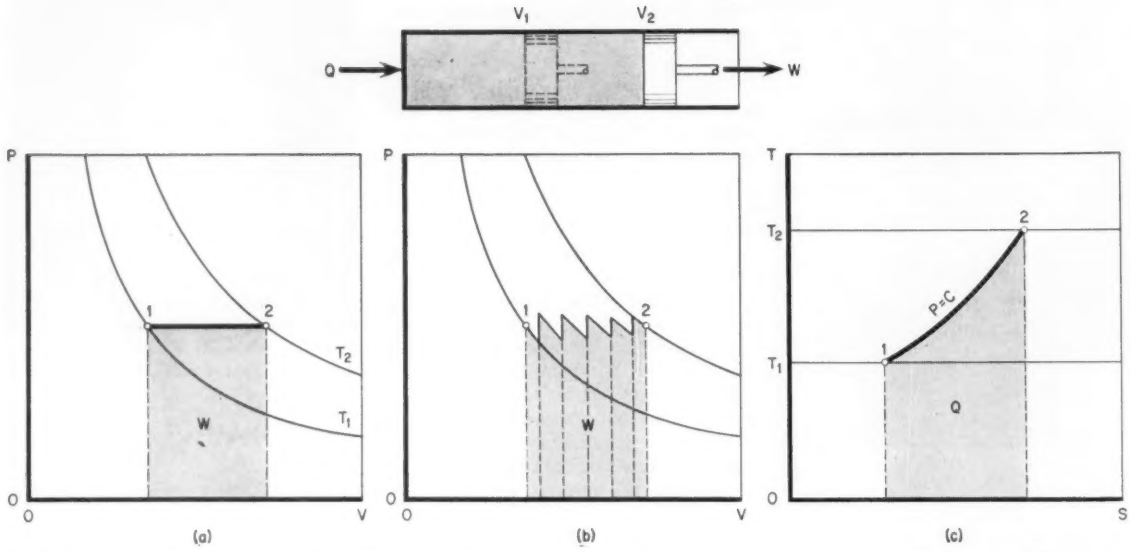
Table 1 lists the work and heat transfers at constant temperature between the state points in Fig. 2. When the heat transfers are divided by the temperatures at which they take place we see that the ratios are equal between pairs of adiabatic processes. We let $Q/T = S$.

We also just learned that the volume ratios of the constant-T processes between common pairs of adiabatics are equal. For example in Fig. 2:

$$\frac{V_2}{V_1} = \frac{V_5}{V_4} = \frac{V_8}{V_7} = V_r$$

$$\frac{15}{10} = \frac{11.37}{7.59} = \frac{9}{6} = 1.5$$

between adiabatics *1-4-7* and *2-5-8*.



4 Figuring entropy changes during constant-*P* process depends on breaking up process into large number of constant-*T* processes so that pressure change is so small it can be assumed to be constant. Areas measure corresponding *W* and *Q*

We deliberately chose the volume ratio for the constant-*T* processes between the adiabatics *2-5-8* and *3-6-9* to be the same as between the adiabatics *2-5-8* and *1-4-7*. As Table 1 shows, this makes the heat/temperature ratio *S* all equal for the constant-*T* processes. All the *Q*'s and *W*'s were figured by equation (A) page 89.

When we combine the constant-*T* processes, such as *3-2* and *2-1* into one process *3-1*, note in Table 1 that $S_{32} + S_{21} = S_{31}$. We have apparently hit on some kind of a relationship.

Let's transpose our ratio $Q/T = S$ into $Q = TS$. We know *T* to be a property of a gas, now let's assume that *S* is a property also. If we plot the two properties as coordinates on a graph as in Fig. 3*a* we see that for the constant-*T* process *3-2* at 500 °R we draw a horizontal line at 500 with a length S_{32}. Then by our equation $Q = TS$ the area under the line equals the heat transferred during the constant-*T* process Q_{32}. In Fig. 3*b* we do the same thing for constant-*T* process *3-1*, and have a horizontal line S_{31} long with the area under it equalling the heat transferred Q_{31}.

Fig. 3c shows that by difference S_{21} must be the length from 0.2012 to 0.4024 on the *S* scale, since we showed above that these quantities are additive. These lengths are really *differences* in quantities, for instance, $S_{31} = S_1 - S_3$ and $S_{32} = S_2 - S_3$. The quantity S_3 corresponds to the state *3* in Fig. 2, S_2 to state *2*, and S_1 to state *1*. We can conclude that *S* is a property.

We can project this reasoning to all nine state points in Fig. 2 and we would then come out with a graph as in Fig. 3*d*. Let's identify the property *S* as *entropy*. The state points *3*, *6*, and *9* have an entropy of zero. But since we picked these states arbitrarily in Fig. 2, we can see that the zero entropy value is just arbitrary and not absolute. In general we deal with *changes* in entropy and not the absolute values of entropy. Theoretically, it would seem that a gas has zero entropy at zero pressure, temperature and specific volume. Then as we add heat *Q* all the properties including the entropy increase. Wherever we have information on the behavior of a gas from zero temperature to higher levels we would be able to calculate the absolute entropy of a gas. There still is some information missing on all gases, however, though scientists have approached absolute zero within fractions of a degree.

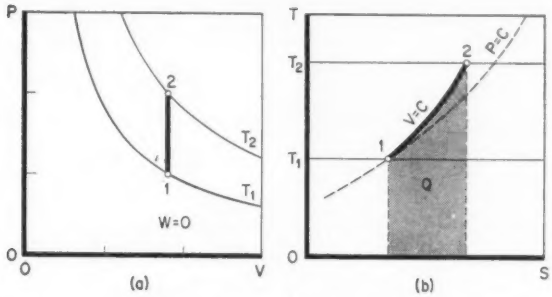
We can make direct measures of properties of a gas, like pressure, temperature, density, specific volume. But entropy cannot be measured directly; as we showed, it is calculated from changes in other properties during processes. It's especially useful in calculating heat transfers during processes.

In deriving the property, entropy, we used the constant-*T* process. But how do we figure entropy (more accurately entropy changes) for the other processes? They must all be based on heat transferred at constant temperature.

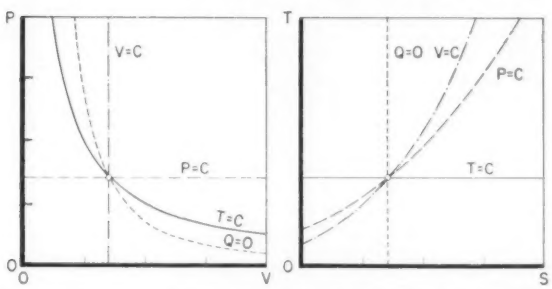
Adiabatic entropy change. During a reversible adiabatic process there is no heat transferred so $Q = 0$. Then since $S = Q/T$ the entropy must be zero. In Fig. 3*d* we can identify the adiabatic processes *3-6-9*, *2-5-8* and *1-4-7* as corresponding to those shown on the P-V graph in Fig. 2. The complete adiabatic process on the T-S graph is a vertical line extending to zero temperature. This ties in with zero heat transfer during an adiabatic process; a vertical line has no area under it so $Q = 0$.

Constant-P entropy change. Next, let us consider the constant-*P* process, Fig. 4*a*. On the P-V graph it appears as a horizontal line and we know the temperature changes during the process. But figuring entropy depends on knowing the amount of heat transferred at constant temperature—what do we do when the temperature varies? Fig. 4*b* shows the reasoning involved. We simply break up the constant-*P* process into a very large number of constant-*T* processes so we can consider the temperature constant during a very large number of small volume changes. If we take a large enough number of elements the saw-tooth path of Fig. 4*b* would become effectively a straight line as in 4*a*. By this line of reasoning we find the equation for $S = Q/T$ of the constant-*P* process can be figured as:

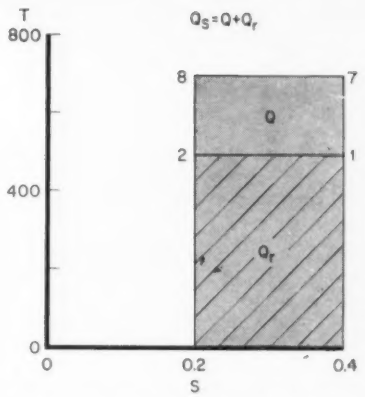
$$S_2 - S_1 = c_p \log_e \frac{T_2}{T_1}$$



5 In constant-V process no work W can be done as shown on (a), but heat transferred Q appears on T-S graph in (b)



6 Process curves passing through one state point of a gas have different shapes on companion P-V and T-S graphs



7 Carnot cycle on T-S graph has simple shape, work depends on net Q

Fig. 4*c* shows the curve of this equation on T-S coordinates. The area under the curve measures the heat transferred during the process. We can see now that we have a pair of companion graphs; P-V. Fig. 4*a*, gives us a graphical measure of work W and T-S gives us a measure of Q.

Constant-V entropy change. So far we have paired up the P-V and T-S graphs for: (1) constant-T process (2) adiabatic process (3) constant-P process. Next, let's see how they compare for the constant-V process. Fig. 5 shows the P-V graph we met before; $W = 0$ and the only energy change can be as Q. But since T is variable while Q flows we need a more complex formula to figure S_2–S_1. By assuming we add very small amounts of Q to the gas at very small steps of increasing levels of constant-T we can find the formula we need. This turns out to be:

$$S_2 - S_1 = c_v \log_e \frac{T_2}{T_1}$$

This parallels the one we found for the constant-P process differing only in using c_v instead of c_p. Fig 5*b* shows the T-S graph for a constant-V process. The dotted curve shows how it compares with a constant-P process passing through state *1*. Since no work W is done in a constant-V process the amount of heat Q that can be absorbed between two given temperatures T_1 and T_2 is less than in a constant-P process. This makes the constant-V curve slope more steeply than the constant-P process. This reduces the amount of area (equivalent to Q) under the curve.

Polytropic entropy change. Finally, we should know entropy changes for a polytropic process in which all factors change simultaneously, see Part 8, POWER, May 1957, p 108. This proves to be a parallel to the previous two equations:

$$S_2 - S_1 = c_n \log_e \frac{T_2}{T_1}$$

where c_n is the polytropic specific heat and equals $c_v\ (k\text{-}n)/(1\text{-}n)$. This usually gives us a process curve on the T-S graph similar to the constant-V or -P curves at some different slope.

Fig. 6 sums up the relative process-curve trends on P-V and T-S coordinates that pass through one state point. The polytropic process can have a curve going in any direction through the state point. We will be using these curves quite often so it's wise to memorize them for future use.

Using T-S graph. As we learned, the P-V graph gave us a picture of net work available in the Carnot cycle. Later on we'll see that this applies to many different types of cycles as well. The P-V graph, however, gives it to us only from the mechanical work standpoint. Any heat transfers Q must be inferred from the simple energy equation $Q = E_2 - E_1 + W$.

On the other hand, the T-S diagram gives us a picture of net energy available in the Carnot cycle also; but gives it from the heat-transferred standpoint. For reversible processes the net areas on both types of graphs are equal for the Carnot cycle, one in terms of heat and the other in terms of mechanical work.

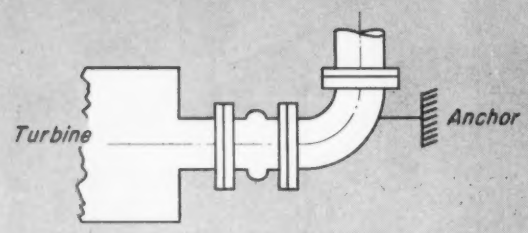
Figure 7 shows how the Carnot cycle appears on T-S graphs. In Fig. 2 we can assume that a Carnot cycle works between the state points *1-2-8-7*. Then if all four processes are reversible the net area enclosed measures the mechanical shaft work output. Remember, areas under the process curves (not outlined in Fig. 2) measure the amount of work done on or by the gas during the process.

Figure 7 shows the corresponding processes on T-S coordinates. The area Q_r under the constant-T process *1-2* measures the amount of heat rejected to the receiver during the first part of the compression process. Adiabatic compression process *2-8* involves no heat transfer so shows no lower area by being a vertical line on this graph.

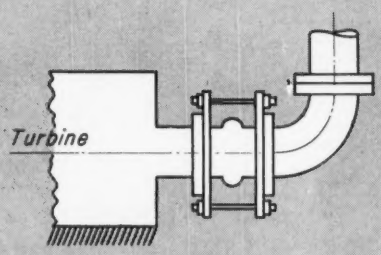
Total area under the constant-T process *8-7* equal to $Q + Q_r$ is the heat transferred from the source to the gas, Q_s. The expansion process ends with an adiabatic process *7-1*, again this involves no heat transfer and it has no area underneath.

The two areas under the receiver and source temperatures are coincident. For the Carnot cycle we know that the net heat absorbed by the gas is equal to $Q_s - Q_r = Q$. But we already showed that $W = Q$ for the Carnot cycle, so the two net areas on the P-V and T-S graphs are equal in quantity but different in units; one is in ft-lb and the other in Btu.

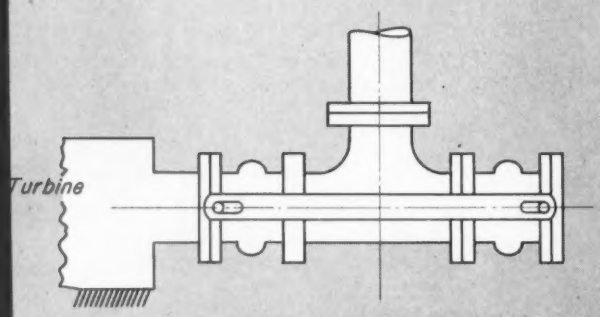
The next part deals with the reversed Carnot cycle and other ideal heat-engine cycles—in a forthcoming issue.



1 Expansion joint with anchored elbow may put too much thrust on turbine

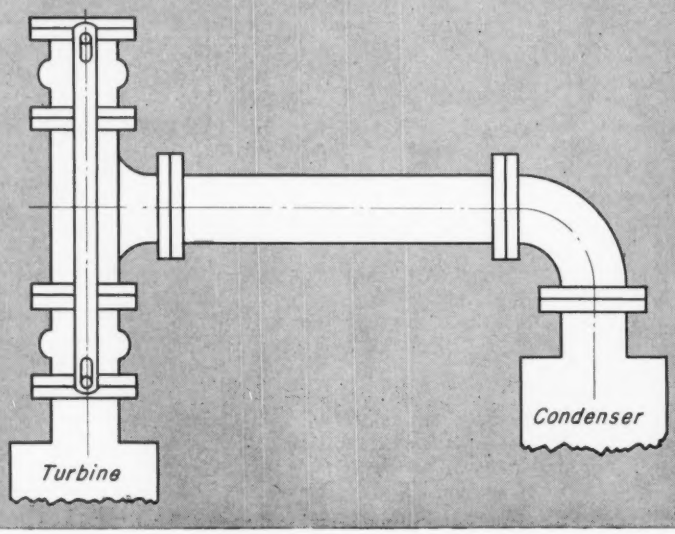


2 Tie rods put expansion joint under shear stress instead of compression



3 Tie rods on these expansion joints prevent thrust from internal pressure acting on the turbine flange

4 These tie rods on expansion joints in turbine exhaust line prevent creating large lifting forces →



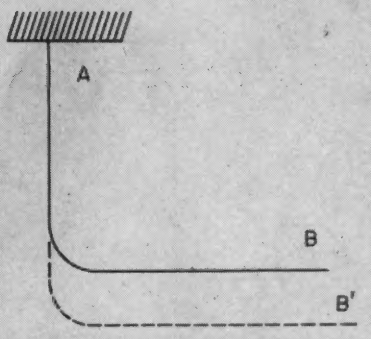
New standards issued by the National Electrical Manufacturers Association spell out the conditions that must be met to stay out of trouble when hooking up steam piping to mechanical-drive turbines and small turbine-generator units, 2000 to 10,000 kw rated capacity

How to connect piping to steam turbines

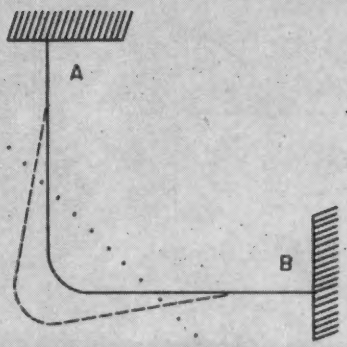
► STRESSES IN PIPING SYSTEMS must stay within limits specified by rules such as the ASME *Boiler Code*, ASA *Code for Pressure Piping* and any local codes that may apply. Jurisdiction of these codes usually stops at turbine openings such as: trip and throttle valve flange, exhaust flange, extraction flanges, induction flange. Piping systems connecting to steam turbines must conform to additional limitations.

Steam turbines, being precision machines, must maintain close clearances between static and moving parts while they unavoidably expand. Pipe reactions at the turbine connections can exert forces that will seriously distort and damage the machine if not controlled.

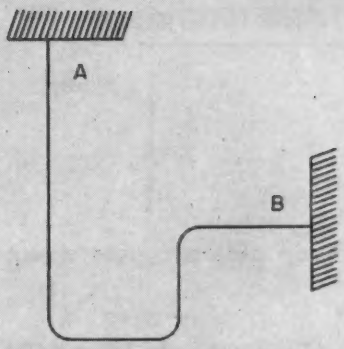
These reactions include pressure forces, bending moments and weight of the pipe. Small pipe forces can lead to large moments at the turbine connections and very large forces at the turbine supports. Critical connections include (1) high-pressure steam inlet (2) extraction openings (3) low-pressure admission inlets and (4) exhaust.



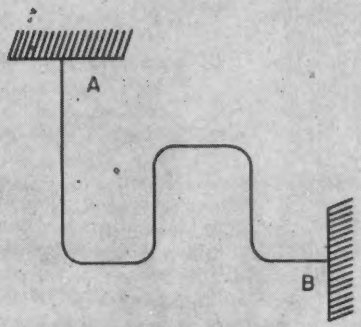
5 Cold pipe **AB** expands to position **AB'** when it is heated and free at end **B**



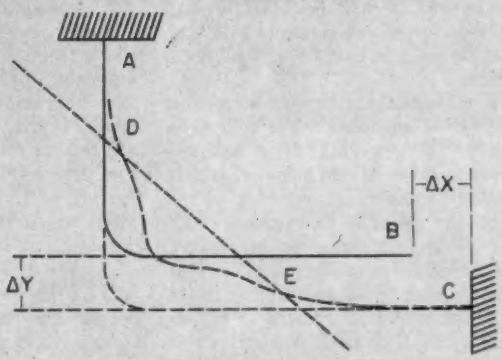
6 Cold pipe **AB** anchored at both ends warps to dotted line when it's heated



7 Expansion loop in pipeline limits stresses when pipe expands while hot



8 Expansion loops may also be arranged this way to limit internal stresses



9 Pipe cold springing puts it under allowable stress while cold and limits stresses when pipe is heated

Sometimes other pipe connections should be checked. Three types of stresses develop in pipe systems during operation, from (1) steam pressure (2) thermal expansion and (3) dead weight.

Steam-pressure forces are most important in low-pressure and vacuum lines. These often use expansion joints for flexibility. But an expansion joint improperly used may cause a pipe reaction greater than the one to be eliminated. An expansion joint produces an axial thrust equal to the area of the largest corrugation times the internal pressure.

The force compressing or elongating an expansion joint can be quite large and may exceed the limits for the exhaust flange. To have the lowest reaction, avoid absorbing pipeline expansion by axial compression or elongation. When expansion joints must be used they should be properly located and applied.

Fig. 1 shows an expansion joint in a pressure line. Axial thrust from the expansion joint tends to separate turbine and elbow. To prevent this, the elbow must have an anchor to keep it from moving. The turbine must also absorb this thrust and becomes an anchor. This force on the turbine case may be greater than allowable. Generally, this method should not be used.

Fig. 2 is the same as Fig. 1 with tie rods added on the expansion joint. The tie rods limit joint elongation and withstand axial thrust created by the internal pressure without transmitting it to the turbine flange. The tie rods eliminate any axial flexibility, but the joint is still flexible in shear—the flanges may move in parallel planes. Expansion-joint location in the piping should put the joint in shear instead of tension or compression.

Fig. 3, frequently used, also has tie rods on the expansion joints. This arrangement prevents any thrust from internal pressure being transmitted to the exhaust flange and retains the axial flexibility of the joint. It may be used for either vacuum or pressure service.

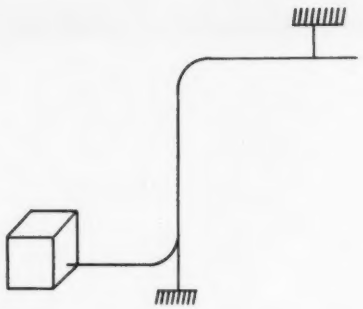
Fig. 4 shows an arrangement frequently used for a condensing turbine with an up exhaust. Because of the large size of the exhaust piping it will be relatively stiff. An expansion joint must be used to care for thermal expansion.

An unrestricted expansion joint at the turbine-exhaust flange exerts an upward or lifting force on the turbine flange which may be excessive. Fig. 4 has the flexibility to care for thermal expansion without imposing lifting forces on the turbine. The expansion joint is in shear, the preferred effect. The relatively small vertical expansion compresses one joint and elongates the other. This causes only a small reaction, well within the turbine flange limits.

Temperature expansions. In Fig. 5, a pipe connected to *A* with no restraint at *B* will take the position shown by the dashed line when heated. If both *A* and *B* are rigid points that cannot move, the pipe takes the shape shown by the dotted line in Fig. 6 when heated.

Expansion loops as in Fig. 7 and 8 may be used to reduce pipe stresses. When piping does not have to be confined to one plane, torsional flexibility will reduce stresses. ***(Turn page)***

Keep pipe stresses down at turbine flanges



10 Turbine case when hot would carry entire weight of pipeline — avoid

Prestressing the pipe in cold condition, *cold springing*, also reduces stresses during hot condition. Using these principles in combination gives a design with enough flexibility to keep stresses, forces and moments within allowable limits in both hot and cold conditions.

In cold springing the pipe is cut short and forced into place while cold as in Fig. 9. This lowers the forces and moments in hot condition below what they would be without cold springing. *A* and *C* are the points to be connected. ΔX and ΔY are the respective expansions.

For welded connections, the pipe must be bent by an applied moment to make the weld faces parallel as well as just pulling *B* up to *C*. Neglecting this produces a moment in the hot condition and only a partial cold sprung effect will be achieved. Whenever possible, facilitate pipe assembly by placing field welds at points of minimum moment, *D* and *E*.

Sometimes expansion joints must be used for additional flexibility at extraction openings, low-pressure admission openings or noncondensing exhausts. These should be avoided whenever possible; but when used they should have stays to take up the pressure thrust.

Dead-weight stresses. Pipe hangers or supports should completely carry the dead weight of the piping. Two types of hangers may be used: rigid and spring. Use rigid supports with an unrestricted expansion joint and also to limit line movement in preventing excessive deflection at any point. Don't use rigid supports where thermal expansion may move the pipe away from the support.

Heating the turbine case in Fig. 10 would lift the base elbow from the rigid support and make the turbine support the pipe weight. On top of this, expansion of the vertical run of pipe would take the load off the pipe hanger above and make the turbine case completely carry the pipe dead weight.

Fig. 11 illustrates how either a rigid pipe hanger or a base elbow with a sliding or rolling contact surface may be used with a restrained expansion joint. When the thrust by an expansion joint is less than the exhaust flange limits and no restraining tie rods are used, the pipe must have an anchor as shown in Fig. 12. This condition rarely exists; preferably eliminate most of the pipe reaction as in Fig. 11 rather than just stay within the stress limits.

Spring hangers carry dead weight when thermal expansion causes pipe movement; this changes the spring tension or compression as well as the hanger loading a small amount but will not remove the load from the hanger. Pipe-design manuals specify hanger spacing to give proper support. Additional supports or rearrangement of supports may be needed to correct resonant vibrations in piping.

Don't use a spring support to oppose the thrust of an expansion joint. When removing the pressure from the line, the spring support will exert a force equal to that of the expansion joint in the opposite direction.

MECHANICAL-DRIVE TURBINES

Forces and moments. The following rules limit the allowable forces and moments exerted on mechanical-drive steam turbines by steam-inlet, extraction and exhaust connections:

1. Total resultant force and total resultant moment imposed on the turbine at any connection must not exceed:

$$F = \frac{500D - M}{3}$$

F = resultant force, lb — includes pressure forces where unrestrained expansion joints are used at connection except on vertical exhausts covered under Item 3, below.

M = resultant moment, lb-ft

D = pipe size of connection (IPS) in in. up to 8 in. diameter. For larger sizes use value of $D = (16 + \text{IPS})/3$.

2. Combined resultants of forces and moments of inlet, extraction and exhaust connections, resolved at center lines of the exhaust connection must observe the following two conditions:

a. These resultants must not exceed:

$$F_c = \frac{250D_c - M_c}{2}$$

F_c = combined resultant of inlet, extraction and exhaust forces, lb

M_c = combined resultant of inlet, extraction and exhaust moments and moments resulting from forces lb-ft.

D_c = diameter, in., of circular opening equal to total areas of inlet, extraction and exhaust openings up to 9 in. diameter. For larger values use $D_c = (18 + \text{equivalent diameter})/3$.

b. Components of these resultants shall not exceed:

$F_y = 125\ D_c$; $F_z = 100\ D_c$; $F_x = 50\ D_c$; $M_y = 125\ D_c$; $M_z = 125\ D_c$; $M_x = 250\ D_c$

F_y = vertical component of F_c

F_z = horizontal component of F_c at right angles to turbine shaft

F_x = horizontal component of F_c parallel to turbine shaft

M_x = component of M_c in a vertical plane at right angles to turbine shaft

M_y = component of M_c in a horizontal plane

M_z = component of M_c in a vertical plane parallel to the turbine shaft

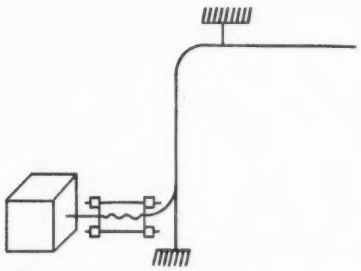
See Fig. 13 for diagram of these components.

3. For turbines with a vertical exhaust and an unrestrained expansion joint at the exhaust, an additional force caused by pressure loading is allowed. (The additional force acts perpendicular and centrally to the face of the exhaust flange.)

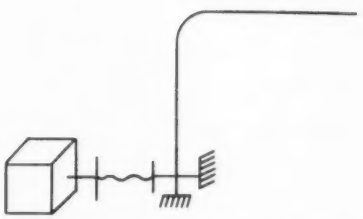
For this application, calculate the vertical force component on the exhaust connection, excluding pressure loading, and compare with one-sixth the pressure loading on the exhaust. Use the larger of these two for vertical force component on exhaust connection in calculating Items 1 and 2, above.

Force caused by pressure loading on the exhaust is allowed in addition to values established by the above up to maximum vertical force (lb) on the exhaust connection (including pressure loading) of 15½ times the exhaust area (sq in.).

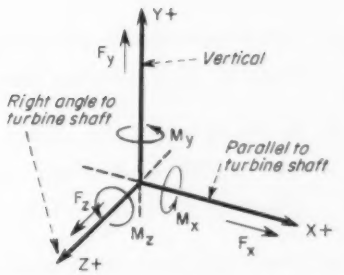
4. These allowable forces and moments apply to the turbine structure only. They do not apply to the forces and moments in the connecting piping,



11 Restrained expansion joint with either support cuts pipe reaction



12 Pipeline with expansion joint must be anchored at elbow next to joint



13 These forces and moments must be figured for every turbine connection

flange and flange bolting which should not exceed allowable stress as defined by applicable codes and regulatory bodies.

TURBINE GENERATORS: 2 to 10 mw

The same general principles above apply also to piping connected to steam turbines driving alternators. The turbine is usually anchored adjacent to the exhaust casing. A flexible plate or sliding support holds the high-pressure end and permits the turbine to move along its axis but not in the transverse or vertical direction. While the turbine is supported on or near its center line, neither the inlet, exhaust or other connection is necessarily on the center line, so, these may move with temperature change. In providing restraints to, and allowing expansion for the piping, movements of the inlet, exhaust and other connections on the turbine must be taken into account.

Condenser connection. The condenser may be either connected solidly to the turbine exhaust or through an expansion joint.

When solidly connected the turbine carries the condenser weight under all conditions. Changes of pressure in the condenser do not change the suspended load on the turbine. Weight of cooling water, however, and weight of water used for leakage testing, react on the turbine exhaust. Provision must be made to carry this load. Spring supports can partly reduce this load on the exhaust.

An expansion joint at turbine exhaust has the advantage of freedom of movement vertically between the two and eliminating the weight of the condenser and its water as a load on the exhaust flange. Some axial and lateral movement is possible, but limited. Forces applied to the turbine by the vacuum load across the exhaust flange opening is a disadvantage. The expansion joint may be quite rigid in torsion and transmit moments to the turbine.

Attention must be given the forces and moments on the condenser caused by piping connections to the condenser. For example, the circulating-water pipes are often of large size and connected to the condenser through expansion joints. Water pressure across the openings raise net forces and moments that must be considered in their effect on the turbine exhaust.

Allowance must also be made for the normal movement of the condenser from expansions either in the turbine or condenser shell. Specific criteria for designing piping connections include:

1. Maximum downward loading should not be more than 30 psi of exhaust area plus 10,000 lb.

2. Minimum downward loading should not be less than 3 psi of exhaust area or 10,000 lb, whichever is smaller.

3. Eccentricity of downward loading referred to exhaust-opening center should not exceed 12 in. in the sideways direction and 6 in. in the axial direction.

4. Maximum horizontal force on the exhaust flange in either sideways or axial direction should not exceed 1.5 psi of exhaust area or 5000 lb, whichever is smaller.

5. Maximum moments in lb-ft acting on the exhaust flange from all effects, except eccentricity of downward loading, should not exceed:

a. about the axis of the machine—4 times exhaust area in sq in. plus 2000.

b. About the vertical axis at exhaust center—one half the maximum moment about the axis of the machine.

c. About the transverse horizontal axis at the exhaust flange—equal to the moment about the vertical axis.

Noncondensing turbines. Forces and moments on these units should be guided by these limits:

1. Treat loading on exhaust flange same as other piping connections.

2. Vertical reaction at any given support from combined forces and moments of any one or all piping connections should not exceed one-half the dead-weight reaction of the turbine at the given support point. This applies to both upward and downward piping reactions. Omit trip and throttle valve in finding dead-weight reaction of the turbine.

3. Horizontal transverse reaction at any support from combined forces and moments of any one or all piping connections should not exceed one-third of total dead-weight reaction of the turbine at the given support point.

4. Axial force on turbine from any one or all piping connections should not exceed one-sixth of turbine weight.

Other connections. Forces and moments on high-pressure, extraction and low-pressure admission connections are limited by these rules:

1. Vertical reaction at either front support or at either exhaust support from combined forces and moments of any one or all piping connections (excluding exhaust connection) should not exceed one-half dead-weight reaction of the turbine at the support point. This applies to both upward and downward piping reactions.

2. Horizontal transverse reaction at front supports from the combined forces and moments of any one or all piping connections (excluding exhaust connection) should not exceed one-tenth total dead-weight reaction of turbine at the front standard.

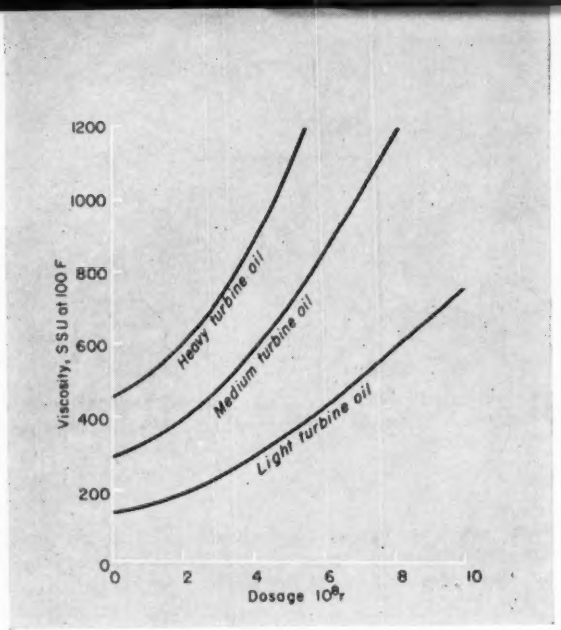
3. Horizontal transverse reaction at exhaust hood supports from combined forces and moments of any one or all piping connections (excluding exhaust connection) should not exceed one-tenth total dead-weight reaction of turbine at the exhaust supports.

4. Axial forces on turbine casing from combined axial forces of any one or all piping connections (excluding exhaust connection) should not exceed one-sixth of turbine weight.

To obtain copies of the complete *Approved Standards* covering both types of turbines, write to: National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y.

- **Some commercial oils and greases can withstand a 10^8r gamma dosage**
- **In some ways the effect of irradiation on lube additives is more significant than the effect on bulk material**
- **Wear characteristics and load carrying capacity is sometimes improved**

Gamma rays improve lubes . . . someways



TURBINE OIL in today's nuclear plant designs will receive about 0.2 rads per hr, needing 10^9 hr to reach 10^8 rads

► GROWTH OF ATOMICS throughout industry has thrown the spotlight, at least in some areas, on the gamma radiations and their effect on commercial lubricants. Turbine speeds, loads and bearing materials in the nuclear power plant will remain essentially as they are in more conventional plants. And with the possible exception of fire-resistant turbine lubricants (POWER, March 1955, p 75) petroleum oil with a viscosity of 150 ssu at 100 F will be used as before.

However, nuclear radiation causes some drastic changes in lubricants, so several questions have popped up: Will lubricants commonly used in everyday applications become completely useless in atomic applications? Will they be useful up to a point? If so, what is that point?

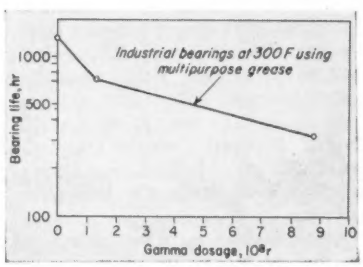
Series of tests conducted by the California Research Corp has helped pin down some answers. At the ASLE Annual Meeting, J R Carroll and S R Calish reported their findings based on samples irradiated to gamma ray source at Idaho's Materials Testing Reactor (MTR). Here a reactor's spent fuel elements were placed within a grid for irradiation with gamma rays alone. Gamma radiation was chosen since it will predominate in applications of reactor accessory equipment. Also, gammas do not produce residual radiation as do neutrons, which leave most materials radioactive. Samples may be inspected after gamma irradiation with a minimum number of health hazards.

Gamma exposures are usually ex-

Wear characteristics of tested oils improved with radiation while three of six . . .

Type of base oil	Turbine oil			Machine oil			Steam cylinder oil		
	Naphthenic			Naphthenic			Paraffinic		
	pale			pale			bright stock		
Oxidation inhibited	Yes			No			No		
Other compounding	Yes			Yes			Yes		
Dosage, 10^8r	0	1.3	6.8	0	0.9	6.1	0	1.2	9.1
Gravity, API	29.6			24.6			22.5		
Flash Point, F	350			355			535		
Fire Point, F	385			410			600		
Viscosity, ssu									
at 100 F	159	182	494	175	183	328	2927	3248	14,252
at 210 F	43	45	63	43	44	52	150	170	491
Viscosity Index	89	93	95	60	60	74	91	91	103
ASTM Pour Point, F	−15			−10			+20		
Carbon residue, %	0.01			0.02			2.2		
Neutralization No.	0.05	0.01	Nil	0.04	0.50	0.50	0.12	0.08	0.05
ASTM Color	1−	2−	3.5	2−	Blk	Blk	8+	8+	8+
Corrosive to copper	No		No	No	Yes	Yes	No	No	No
Falex EP test, lb	1600		1750	1700		4000			
Almen Wear Test, mg				1.0		0.7			

ALL OILS DARKENED plus taking on an acrid odor similar to highly oxidized oils. Automatic transmission fluid failed to show a VI increase with gamma radiation



IRRADIATION markedly reduces oxidation resistance of greases, at the same time trimming back on bearing life as shown above. After 10^8r about 55% of original bearing life is retained. In general, end effect of radiation on lubricants is similar to severe oxidation; lubricants darken while acquiring oxidized odor

pressed in terms of roentgens, considered as the quantity of absorbed gamma energy per unit of material irradiated.

It's interesting to note the simple technique used by the California Research men in determining the effect of gamma radiation on lubricants. First off, about 150 grams of the sample lube were placed in a common tin-plated baby-food can. Then the lid was crimp sealed to the can after providing for pressure-relief venting above 2 psi. Seven sample cans were placed in a 3-in. OD vented canister, then inserted into the MTR gamma grid. Average temperature during exposure ran about 80 F.

Findings are tabulated below. In general, above 5 x 10^6r organic fluids and greases are sensitive to radiation. Below this level there is negligible effect on oils and greases while above 10^{10}r only the most resistant organic structures survive. By comparison, 200 to 800r total body damage is considered lethal to humans.

Oils. Radiation caused all oils to darken and take on an acrid odor, similar to that of highly oxidized oils. Although radiation accelerates oxidative damage, neut numbers after irradiation did not rise beyond 0.5. In some cases a slight floc or haze was noted but no sludging.

As tabulated, radiation increases viscosity of organic fluids. In the dosage range to 7 x 10^8r, almost a straight line relationship exists between the logarithm of viscosity and gamma dosage. Note also that radiation tends to increase viscosity index. Only exception to this was an automatic transmission fluid containing a high molecular-weight polymer as VI improver. Initial decrease in viscosity stems from the breakdown of this polymer. Gamma irradiation appeared to improve wear characteristics of oils tested. However, oils having chlorine-containing additives such as used in MIL-L-2105 gear lubricants, become quite corrosive.

Greases. Dropping point and consistency of greases were altered by radiation. Although all greases softened in the given dosage range, three of the six reached semiliquid stage. At 10^8r, greases did not increase consistency if gelled with the sodium synthetic. Rate of change varied and depended on each combination of oil, gelling agent and additive. Earlier tests showed the trend toward fluidity reverses at high gamma dosages and eventually greases become solids.

Radiation damage to organic lubricants in a nuclear power plant is caused primarily by ionization as a secondary effect from bombardment by fast neutrons, slow or thermal neutrons and gamma rays. Fast neutrons cause damage by interacting with the hydrogen nuclei in the organic materials and ejecting hydrogen atoms as fast recoil protons. These protons then cause radiation damage by upsetting the electronic system of the molecules and producing ionization. Protons of gamma radiation collide with single electrons of the atoms of organic materials, transferring a portion of their energy with each encounter. As pointed out by Hausman and Booser of General Electric, these electrons are ejected and again there is an upset of the electronic system of the molecules with ionization.

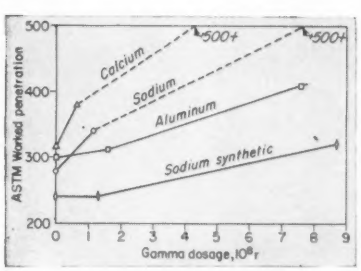
Deprived of an electron, the molecules become an unstable ion and can undergo a variety of chemical changes including polymerization and oxidation. Damage to organics by thermal neutrons results primarily from the capture of these neutrons by the nuclei of hydrogen atoms with the subsequent emission of high energy gamma rays.

Beta radiation (electrons ejected from atomic nuclei) and alpha particles (charge helium nuclei) cause similar damage to petroleum lubricants. However, these latter radiations present no practical problem in a nuclear plant since they are almost fully absorbed.

Synthetic oils vary somewhat in their resistance to radiation. Although the alkali benzenes have better radiation stability, they do not provide as good lubrication in reactor tests as the aircraft type diester fluids or the polyglycol lubricants.

In brief, this all boils down to the fact that for gamma radiation (1) several commercial oils and greases can be used with a dosage up to at least 10^8r (2) in general, the end effect of radiation on lubricants is similar to severe oxidation (3) effect of radiation on lubricant additives is sometimes more significant in limiting their application than effect on the bulk material (4) wear properties and load carrying capacity of certain oils are enchanced by irradiation (5) gamma irradiation improves petroleum VI.

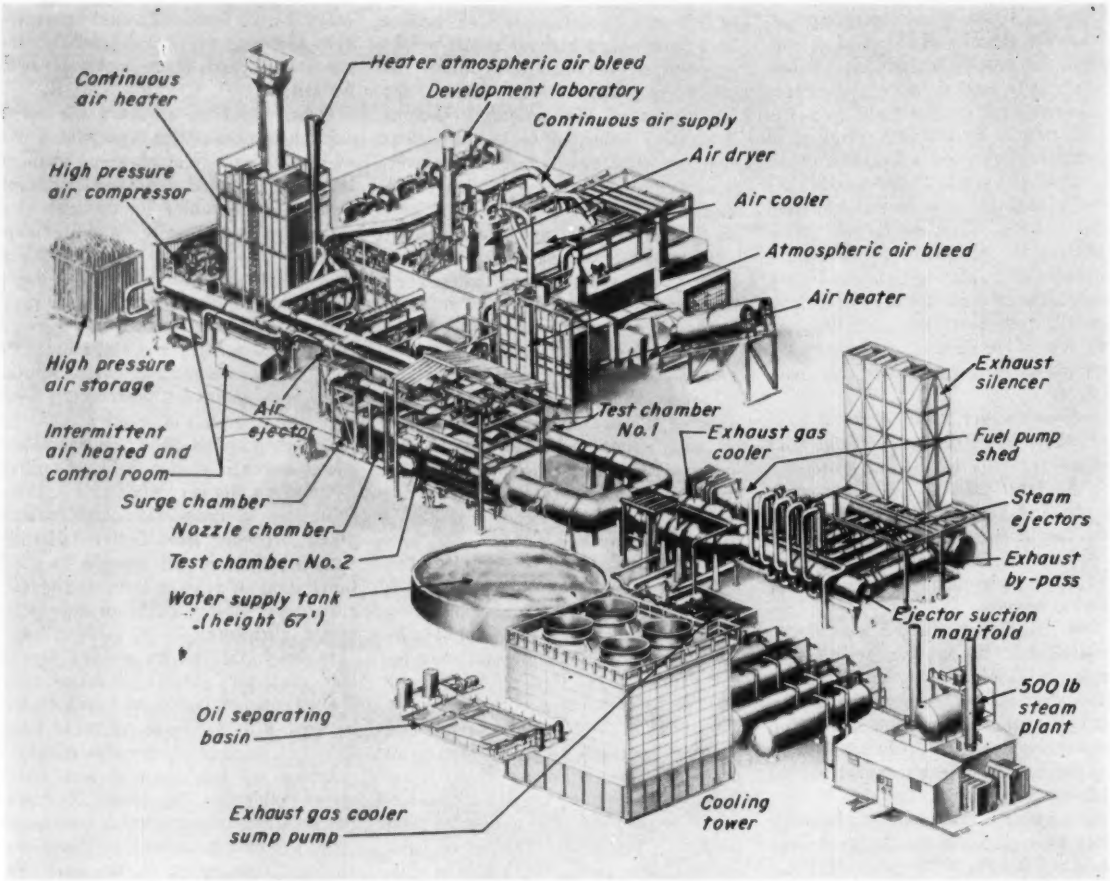
greases reached semiliquid state. At still higher dosages some greases solidify



WORKED PENETRATION changes with increased dosage is but one new operating problem. To reap the full benefits of our present nuclear age we must learn to live with some of the new variables we have created. Problems involved in designing, operating, and maintaining the lubricating systems in irradiated areas is a challenge.

Gelling agent, type	Sodium soap			Calcium soap			Aluminum soap		
% by weight	28			18			11		
Oxidation inhibited	Yes			No			No		
Other compounding	No			Yes			No		
Dosage, 10^8r	0	1.2	7.7	0	0.6	4.5	0	1.6	7.6
ASTM Dropping Point, F	450	456	448	240	155	234	—	265	
ASTM penetration, 77 F									
Unworked	237	227	200	278	305	368	220	292	389
Worked	280	342	500+	317	382	500+	300	313	411
Mineral oil properties									
Flash Point, F	480			340			425		
Viscosity, ssu at 100 F	490			600			1175		
ASTM Pour Point, F	+10						-10		

DROPPING POINT and grease consistency were affected by gamma radiation. At 10^8r the grease, gelled with synthetic sodium, did not increase consistency. Irradiation markedly reduces oxidation resistance. Test procedure called for placing about 150 grams of the sample lubricant into the MTR grid operating at about 80 F



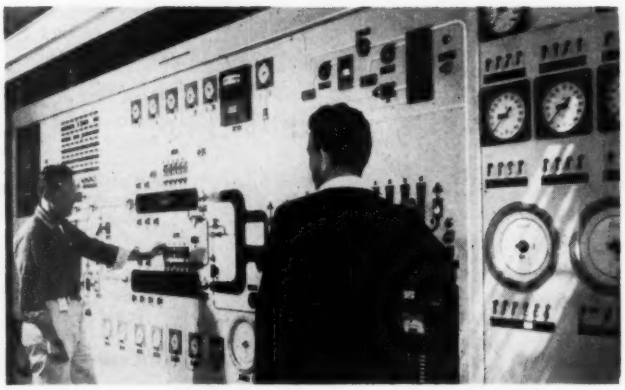
LAYOUT of Curtiss-Wright's large supersonic high-altitude laboratory for development and production testing of ramjets. Flows of air, water and steam produced by this power-service equipment combine to put ramjet engines through their paces

Power services test ramjet engines

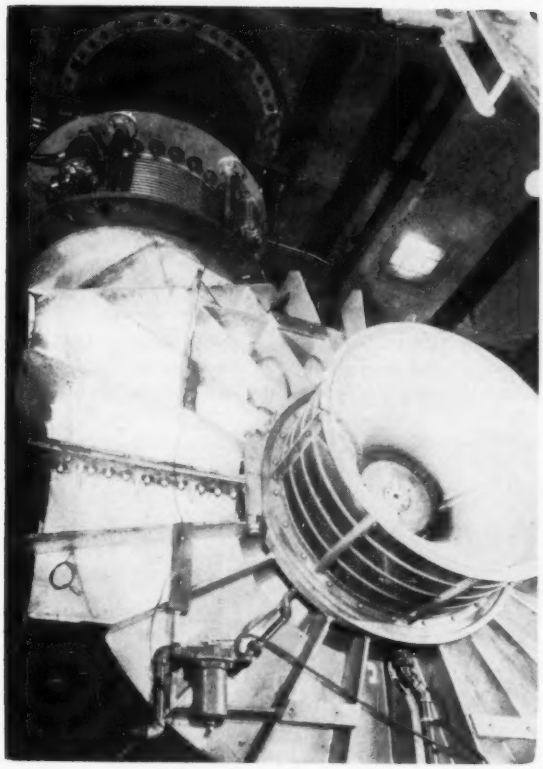
► RAMJET ENGINES are fuel-burning high-speed aircraft power plants. Enormous quantities of oxygen needed for combustion come from air rammed into the engine by the fast forward speed of the aircraft.

Power-service equipment plays a major testing role by creating and maintaining simulated flight conditions at ground level. It supplies air at right temperature and pressure and pumps fuel to the engine. Water-cooling system reduces exhaust gas temperature to reasonable level. Finally, it produces steam to power the vacuum equipment that lowers pressure in the test chamber for high-altitude flight testing.

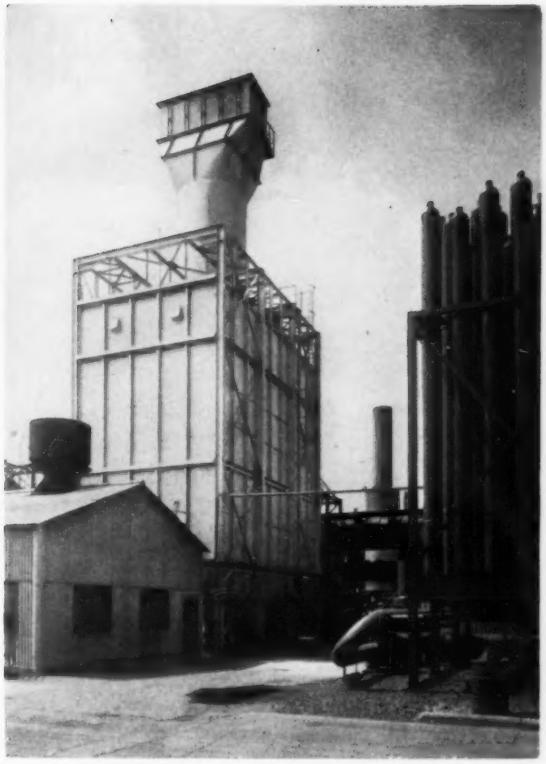
Control-room setup is unique. It has two separate control boards and operating crews. One crew handles the power-service board that controls flow of air, water and steam. The other crew can then devote their full time to running engine tests and collecting operating data.



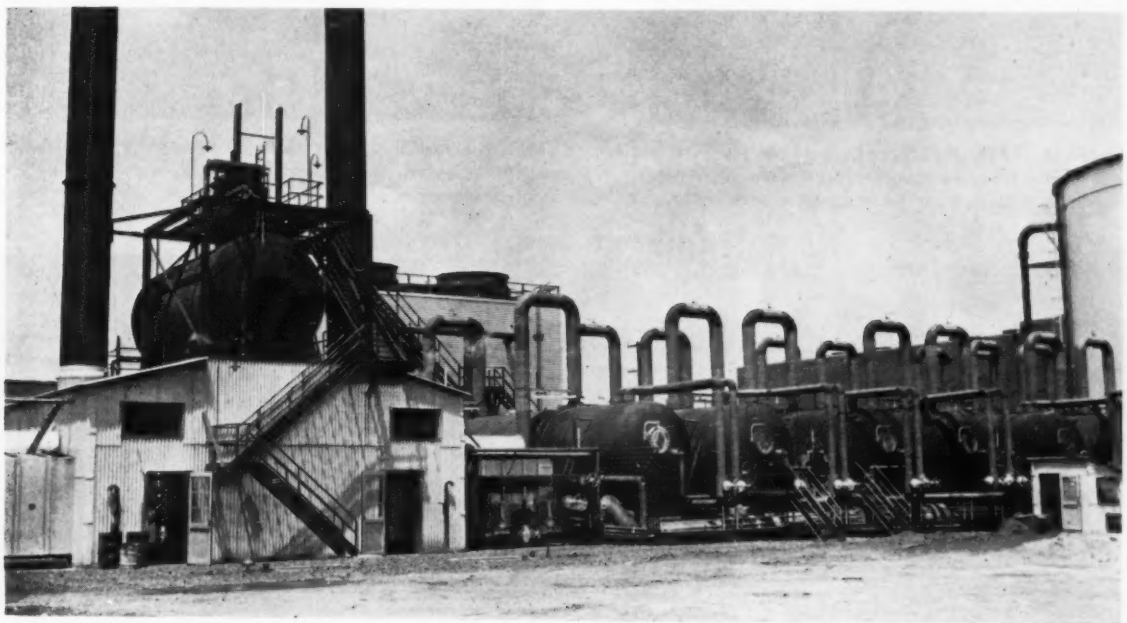
POWER-SERVICES BOARD monitors flow of air, water and steam. Major elements of lab are shown graphically on the panel. Black rectangles, *left*, represent engine test stands



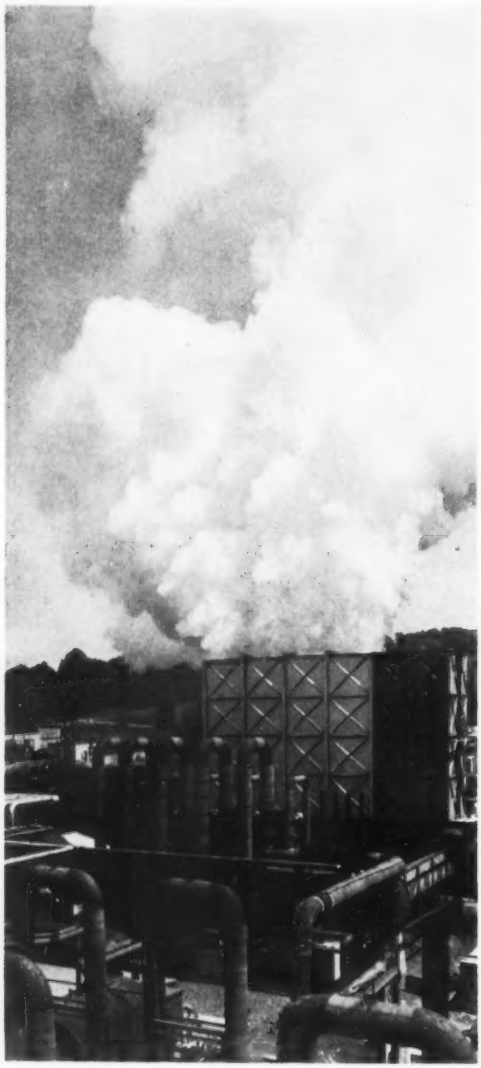
GIANT AIR COMPRESSOR provides steady flow for testing and charges storage bottles with 43,000 lb air at 3200 psi. It's driven by three synchronous motors delivering 17,000 hp



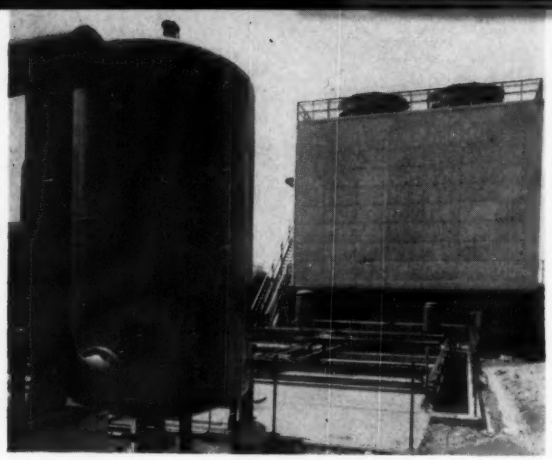
LARGE AIR HEATER is one of three used to heat test air to temperatures found during high-level supersonic flight. Two are continuous type and the third is an intermittent unit



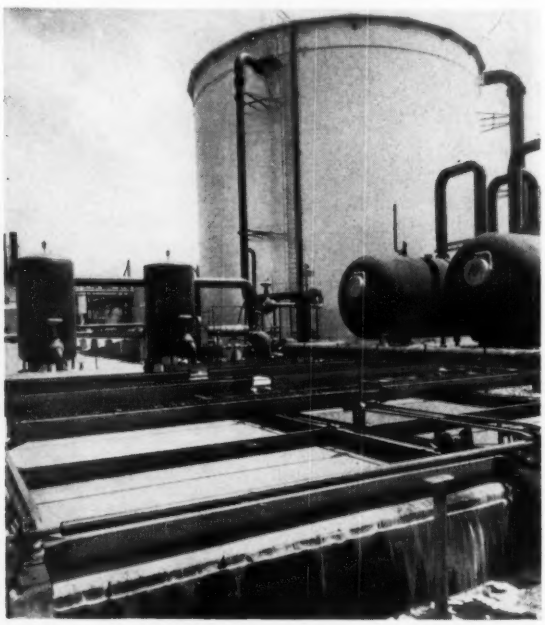
FOUR PACKAGED BOILERS supply 120,000 lb steam per hr at 140 psi to supplement 300,000 lb per hr from main boiler plant. Seven accumulator tanks, *right*, store an extra 245,000 lb of steam. Primary use is for the jet ejector equipment to maintain simulated high-altitude test conditions. At near capacity air flow, lab uses steam at 2,100,000 lb per hr rate



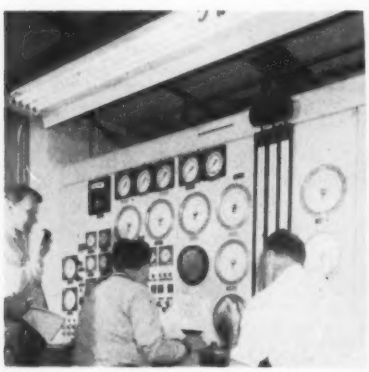
SILENCER STACK discharges huge plume of steam and other gases from the ramjet exhaust gas cooler. Steam is mainly exhaust from the steam jet ejector equipment



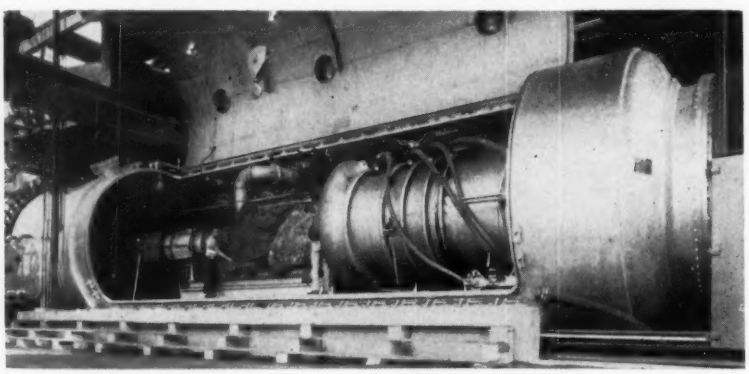
COOLING TOWER handles large water volumes needed for ramjet exhaust gas cooling. Fan housings are visible on top. Tank, *left*, separates petroleum waste from the cooling water



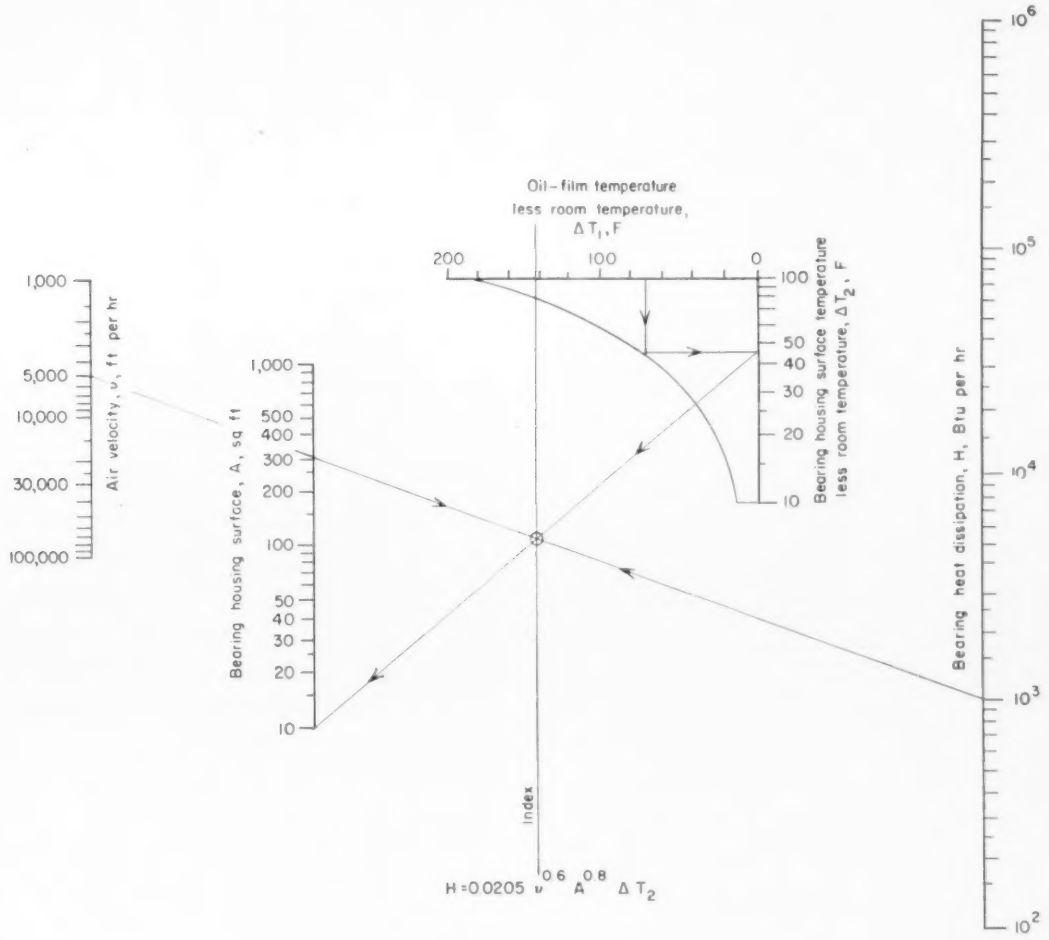
SETTLING BASIN paddles skim off impurities from cooling water. Cleaned water goes through cooling tower and is stored in two million gallon tank, *background*, for reuse



THREE MAN CREW runs engine tests from main board in control room. Tester standing at left is the team quarterback



RAMJET TEST STAND is 97-ft long with an inside diameter of 14 ft. Side hatch is open to admit engine. Entire test chamber is water jacketed to keep the intense combustion temperatures (3500 F) inside. Air enters at left and exhausts at right



Bearing heat dissipation

► HEAT OF FLUID FRICTION in oil-film bearings must be dissipated to the surrounding air. For oil stability and favorable heat-transfer conditions, oil temperature should be kept in the range 130 to 150 F. The bearing-housing surface offers the greatest resistance to heat transfer. So the heat-transfer coefficient depends mostly on bearing size, temperature and movement of the surrounding air.

Formula, above, shows the relations for figuring heat dissipation. Labels on the scales in the nomogram explain the formula symbols. The chart has been based on air thermal conductivity of 0.015 Btu per hr, sq ft, F, ft.

Example: Find the heat dissipation of a bearing with an oil temperature of 145 F when the room air temperature is 75 F. The bearing housing has 10 sq ft of surface. Air flows upward past the bearing at 5000 ft per hr. First find $\Delta T_1 = 145 - 75 = 70$ F. Trace from this value vertically down to the curve and then horizontally to the ΔT_2 scale. Connect this value with 10 sq ft on the A scale by a straight line and find the intersection on the index line. Finally, connect this intersection with 5000 on the v scale and project to the H scale to find 1000-Btu-per-hr heat dissipation.

If you wish to find heat produced by a bearing use *Data Sheet No. 287*, POWER, May 1956, p 103. If this exceeds heat dissipation forced cooling must be used.

H W HAMM, *York, Pa.*

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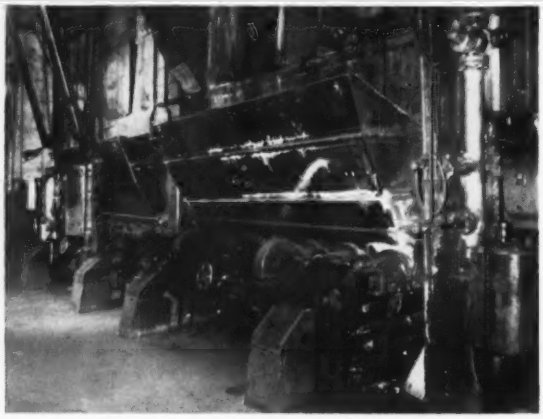
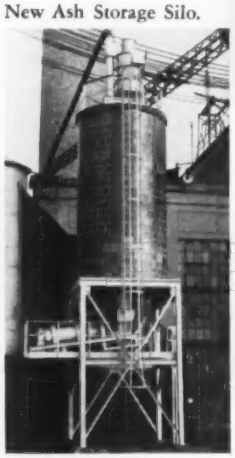
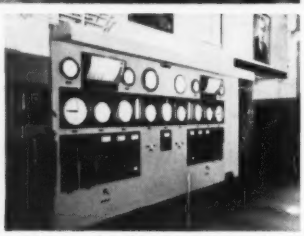
Power Plant Modernization at



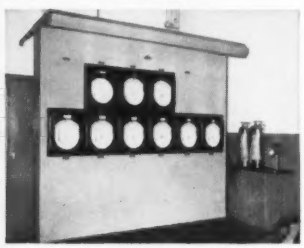
Two 30 year old stoker fired boilers that were replaced.

New Ash Storage Silo.

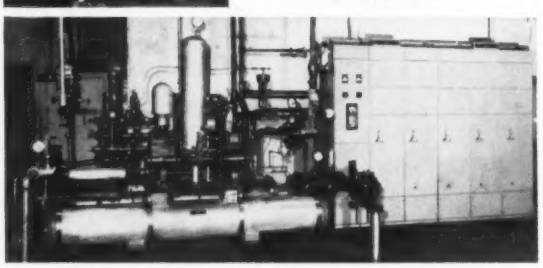




New Combustion Control Panel Board.



New Steam Flow Meter Panel Board.



Oil Heater and Load Center.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

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A 1956 POWER CITATION WINNER

Replacing two of six 6000 sq. ft. horizontal water tube boilers with

TWO 60,000 LBS/HR RILEY BOILERS
Complete with Riley Coal/Oil Burners, Riley Pulverizers, Automatic Controls

give Thomas A. Edison, West Orange, N. J.

- **Doubled steam capacity per sq. ft.**
- **16% increase in boiler efficiency**
- **More flexible fuel selection**
- **A 20% annual return on net investment of 2.75 mills per Btu.**
- **A reduction in coal and stoker parts inventories**

Here again is a modernization program that proves conclusively that it pays to modernize . . . and with Riley boilers and fuel burning equipment. Because Thomas A. Edison Industries selected Riley equipment it was able to integrate both boiler and fuel burning equipment into a system that has produced outstanding savings, higher boiler efficiencies, higher fuel economies, lower maintenance and reduced operating expense.

The Riley RX Boiler is compact; with the exclusive single header hopper as an integral part of the furnace it provides ideal conditions for firing high ash coals and multiple fuels. The RX Boiler with single header hopper bottom is particularly recommended for installation in plants that will be firing coal at some future date.

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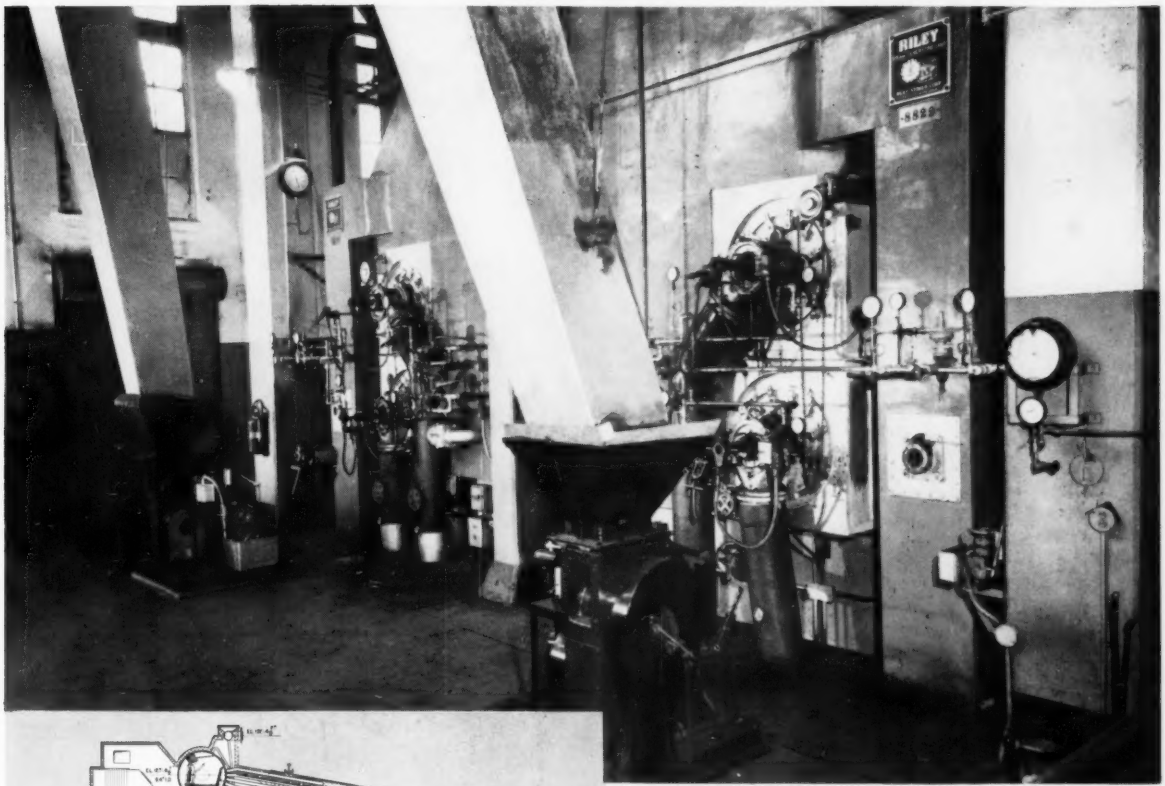
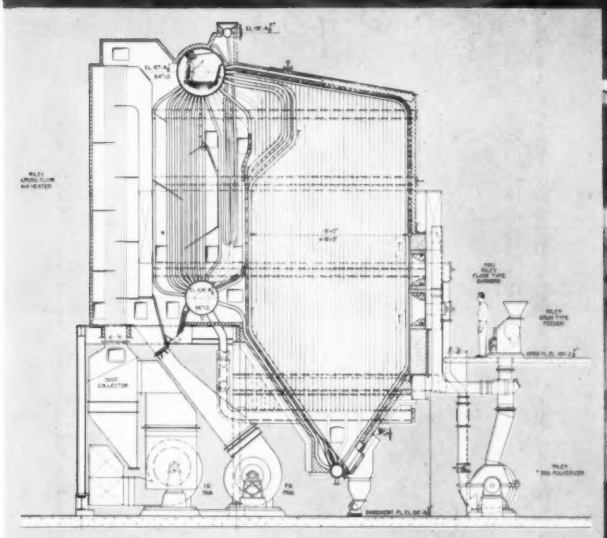
Thomas A. Edison Industries

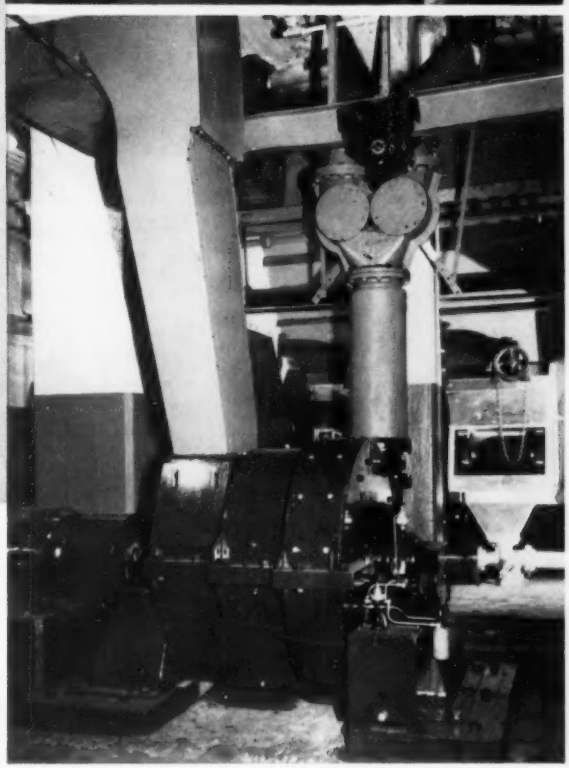
DIVISION OF McGRAW-EDISON COMPANY — WEST ORANGE, NEW JERSEY





Boiler Capacity 60,000 lbs/hr. 515 F, 450 design psig.

Photo above shows arrangement of Riley Coal/Oil Flare Type Burners in common secondary air duct. Two Riley Coal Feeders are in foreground.



At right is one of the two #350 Riley Pulverizers. This is the smaller size pulverizer particularly adapted for use in industrial installations. Its quietness and its vibrationless operation are two of its most unique and most desirable features. Tungsten carbide facing on pulverizing elements resists erosive effects of abrasives in high ash coals, reduces maintenance outages. Riley Pulverizers operate efficiently with the wettest coals.

US RUBBER CONVEYOR BELTING

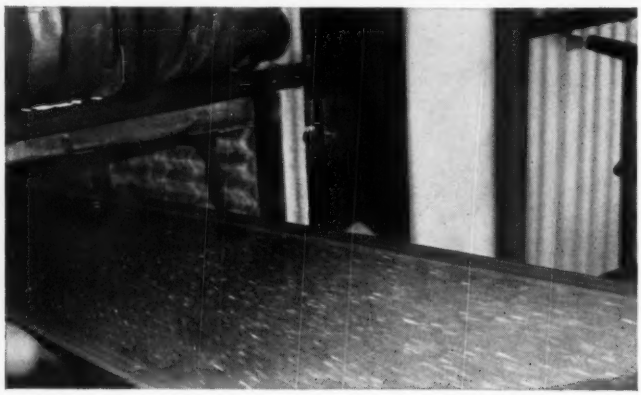
Delivering 367 Tons of Coal per Hour... to insure steady power flow

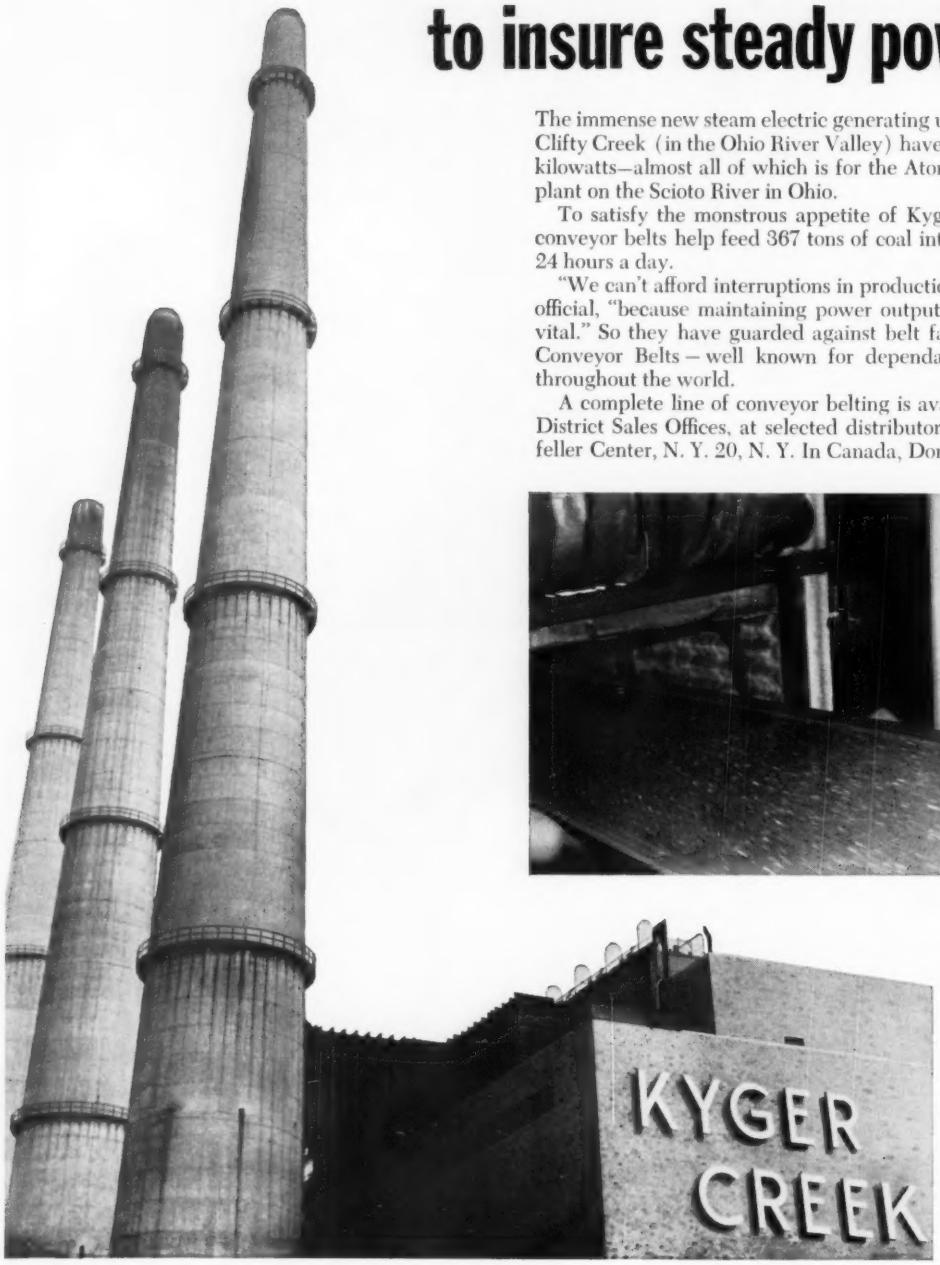
The immense new steam electric generating units at Kyger Creek and Clifty Creek (in the Ohio River Valley) have a capacity of 2,365,000 kilowatts—almost all of which is for the Atomic Energy Commission plant on the Scioto River in Ohio.

To satisfy the monstrous appetite of Kyger Creek, U. S. Rubber conveyor belts help feed 367 tons of coal into its boilers every hour, 24 hours a day.

"We can't afford interruptions in production," says a ranking plant official, "because maintaining power output for the atomic plant is vital." So they have guarded against belt failure by selecting U. S. Conveyor Belts – well known for dependability by power plants throughout the world.

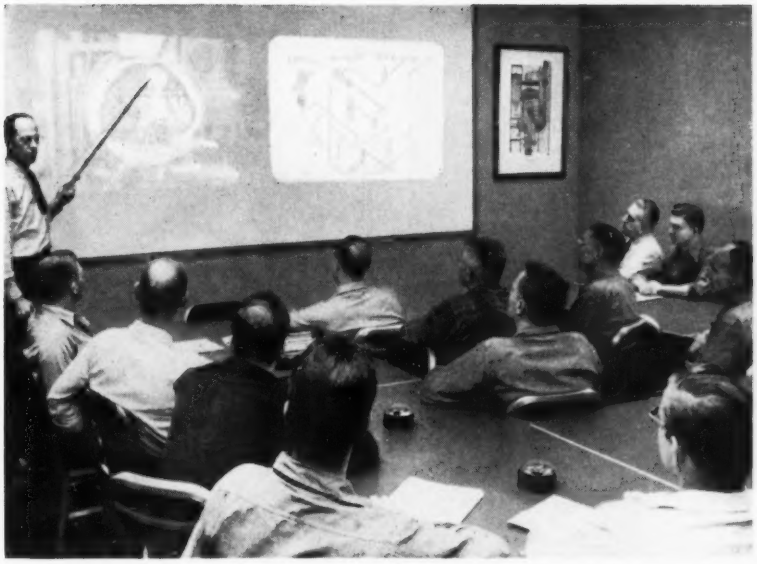
A complete line of conveyor belting is available at the 28 "U. S." District Sales Offices, at selected distributors, or write us at Rockefeller Center, N. Y. 20, N. Y. In Canada, Dominion Rubber Co., Ltd.





(above)
The Number One conveyor belt emerging from the unloader hopper at Kyger Creek. This 48" wide U. S. Matchless® belt provides excellent troughability, extreme rip resistance, fine training and long life. This excellent conveyor system and belting mean considerable savings in manpower to move the coal supply.

US RUBBER Mechanical Goods Division
United States Rubber



Steam-department courses prove popular...

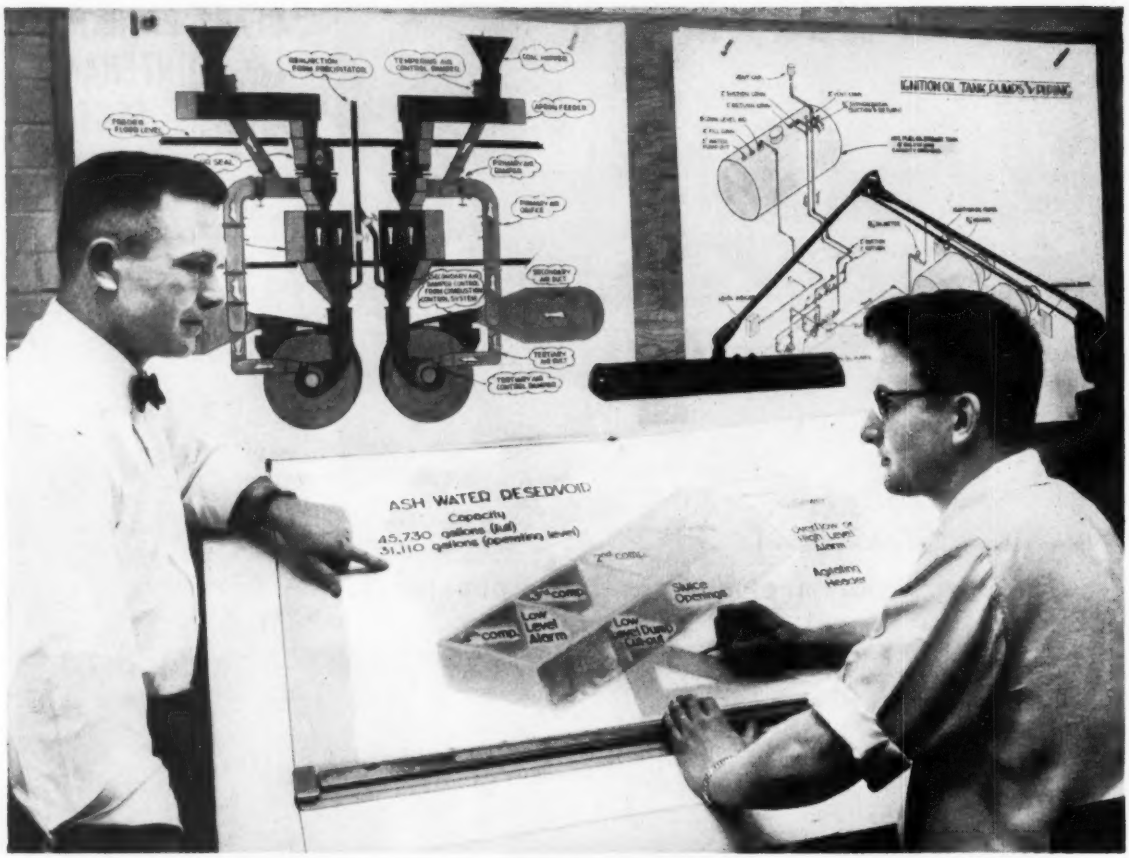
35mm colored slides are widely used in...

Training with visual aids

By T F FINLEY, *Utilities Division*
Eastman Kodak Co, Rochester, N. Y.

► FOR YEARS the steam department of Kodak Park works, utilities division, has had a well-planned on-the-job training program. Specific job-training time was allocated to each job. An experienced operator was assigned to the trainee, with a complete set of sequential operating instructions for the job. Each operator received a personal on-the-job training manual, containing all operational step procedures for the particular jobs. Manuals are reviewed by the supervisors periodically and revised by them whenever it's found necessary.

In 1954, the utilities division launched a power-expansion program, scheduled for completion in 1956. Greater part of program involved new equipment design and new operating techniques. While steam department had highly successful results from their on-the-job training program, it would not do for the new equipment. So we supplemented the on-the-job training and experience with formal classroom instruction. To highlight the program, we



Co-ordinator and associate discuss a technical point in a colored visual aid

went all-out on color photography as a visual aid.

New plant. Plant expansion had one 1400-psi 900-F 400,000-lb-per-hr single-steam drum radiant-heat cyclone-fired boiler. Auxiliaries included a 1500-gpm demineralized feedwater-treatment plant and one 12,500-kw 1400-psi (throttle) 265-psi extraction 6-psi exhaust turbine-generator.

Entire program accommodates about 80 trainees, including instrument, electrical and general maintenance supervisors, shift operators and other staff personnel. Each class has members from each group. All trainees get same training, regardless of job classification. This results in an immense transfer of job knowledge. Here's a breakdown of various job categories:

Shift personnel (steam-electric)	51%
Electrical maintenance	15%
Staff personnel	14%
Instrument maintenance	10%
General maintenance & control	10%

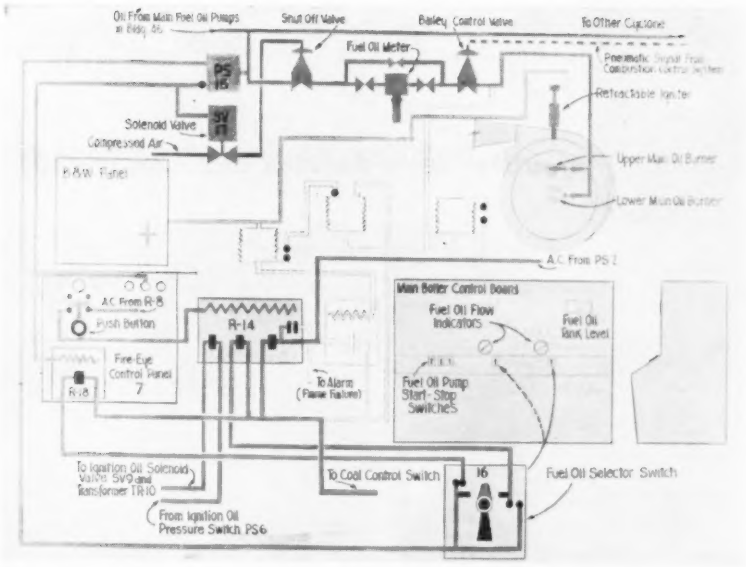
All classes were held on company time, from 2 to 4 pm. Shift personnel received overtime pay to attend when class time didn't conform to their regular work schedule. Makeup classes were scheduled when necessary to complete attendance. We had best results by limiting classes to not more than 10 or 12 members.

Co-ordination of program. Operating and technical information, including manufacturer's instructions, were given to a training co-ordinator. He worked with operating and development engineering groups as follows: (1) Outlined lecture series on subject to be presented. (2) Aided in layout and preparing art for visual aids. (3) Assisted in field photography to correlate detailed subject matter. (4) Helped to prepare reference notes for insertion in training manuals. (5) Conveyed to instructors the manner of presenting subject material. (6) Prepared preview of lecture for supervisor's acceptance before general release. (7) Aided in preparing questionnaires. (8) Maintained master training files, library of indexed visual aids, attendance records, and many other details.

Preparing visual aids. Visual aids were photographed as 35mm color-slide transparencies for screen projection. This included charts, sketches, isometric piping diagrams, block build-up of control circuits and field photography. Visual aids needing art work were sketched on 30x38-in. paper sheets. We used colored inks, crayons, chalk, poster paints, tape or water colors as desired. Color was also applied to sketches, diagrams, etc, that were already printed.

This type of art does need some mechanical aptitude for size and proportion. Once photographed, charts have no real value. But when placed in shadow boxes at various vantage points on the operating floor, they provide a good source of reference for further on-the-job study.

We withheld actual field photography as long as possible, without interfering with our lecture schedule. That let us include as much picture detail as new



VISUAL AID of control circuit is in color, with important features marked by heavy lines. Lettering, symbols and colors help students to remember circuit in the system

Here's why the new training program at our Kodak Park was organized

New training required	Nearest related training
1400-psi steam generator using single steam drum	800 psi, 3 steam drum type
Cyclone-fired furnaces (coal or oil)	Underfeed and chain grate stokers
Pressurized furnace	Balanced or negative draft
Electrostatic flyash precipitator	None
Molten slag handling	Dry ash
Fuel-oil ignition system	Hand lighting
Complexity of safety interlocks to afford alternate firing	None
Barrel type boiler-feed pumps	Split case
Demineralized feedwater treatment with automatic regeneration	Sodium zeolite with manual regeneration
Combustion control based on actual air measurement to each cyclone followed by totalization	Conventional method using pressure drop across boiler gas stream to represent total air flow

construction would permit. Each field picture was taken to best show details required for instructions.

Although photography is the basis for our program, it does not need extensive equipment. You need a good 35mm camera with flash and lens attachments and photo-floods for copy work. Make pictures for depth of mechanical structure rather than for photographic balance or appeal.

Class instruction. Departmental supervision, staff, assistants and development engineers provided each class with an instructor. Classes are held in a soundproofed air-conditioned room equipped to accommodate 25 people.

Photographic projection equipment consisted of a highly reflectant wall screen (to accommodate dual-picture projection), one manually-operated 35mm projector and one automatic remote controlled 35mm projector. Dual projection allows instructor to work from fixed projected isometric sketches and diagrams. Detailed reference is supplemented with actual field photos.

Adequate cover lighting provides instructor with full view of the class. That encourages individual attention, permits note taking. About 25 of the 35mm slides are used in the average two-hour lecture. Classes are conducted in a very informal manner. We find this stimulates class discussion.

At end of each class, reference notes pertaining to the subject discussed are given to each trainee. These are inserted in his personal training reference manual. Notes include isometric sketches and diagrams which he has viewed in class. Some are designed for coloring, if trainee so desires.

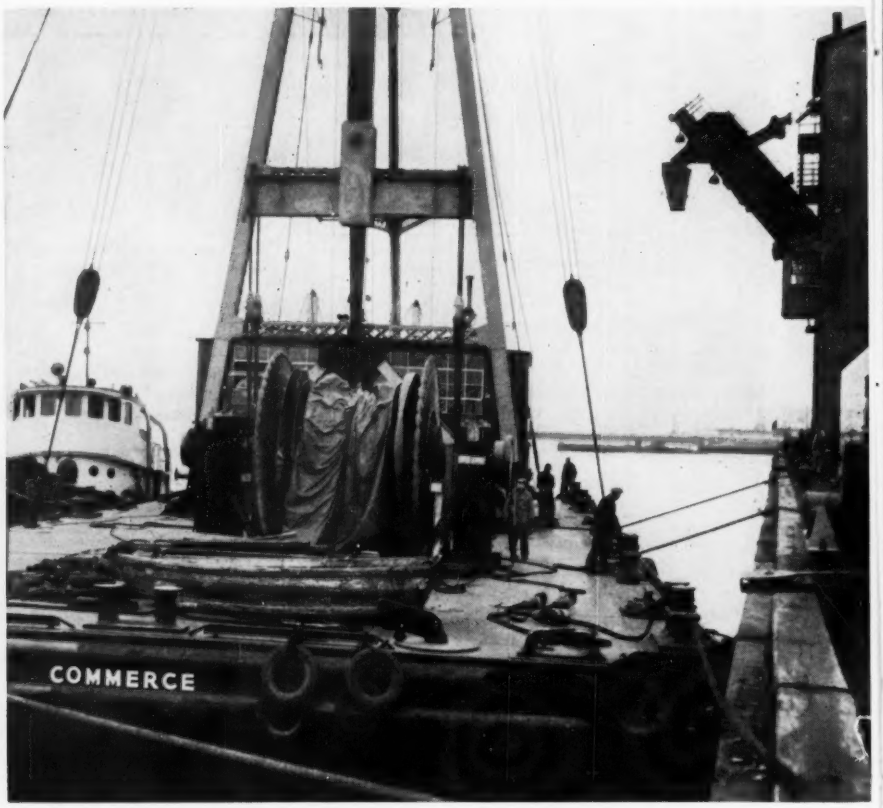
Tests. Periodically, the trainee, without aid of reference notes, is given a classroom questionnaire. These have 25 to 50 multiple-choice questions. Each question has three or more closely related answer choices, with one or two that are acceptable. He writes nothing, just checks a choice of answer. Only key between trainee and results of his test is a number assigned to his questionnaire. Test results are not posted, but trainee may obtain his standing from the instructor by use of our key numbering system.

To date, three questionnaires, totaling 100 questions, show an average rating of 86%. Before new equipment was operated, classes were also held by various manufacturers' engineers. They put emphasis on operating techniques.

Results of program. Exact benefits derived from this training for our new plant may never be known. Yet it appears after one year's operation that training has: (1) Increased job knowledge, which has resulted in better operation. (2) Established a standard interpretation of equipment operation and improved on-the-job training methods. (3) Provided competent handling of unusual unanticipated emergency by our operators. So we feel well-satisfied with our effort in this program.

Turbine spindle is shipped by water on a derrick because it's too

1 Sea-going derrick hoists the spindle aboard from the flatcar at the pier



2 With short sea journey on the Delaware completed, derrick *Commerce* moors at a cold storage yard. Spindle is ready for transfer to the same railroad flatcar

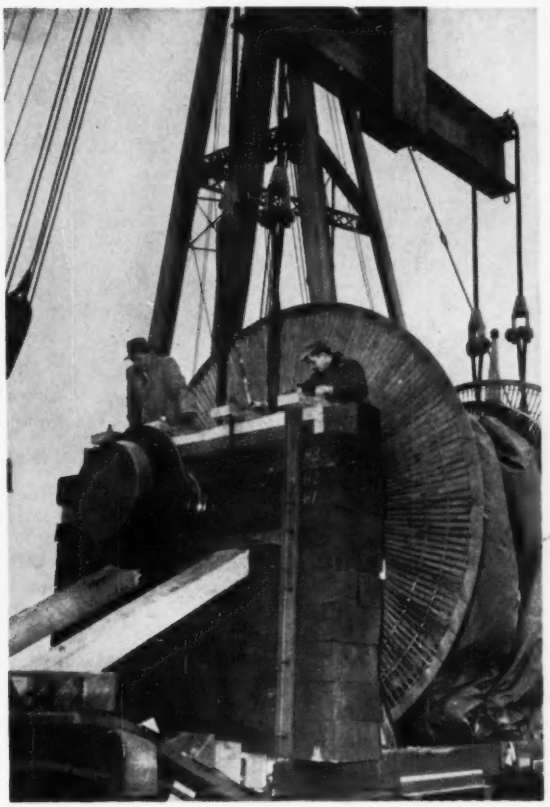
Outage time is cut by adapting turbine for standard spindle

► TURBINE BLADES on the No. 12 unit at the Richmond station of Philadelphia Electric Company needed repair. New blades for this unit are not in current production. Replacement with the same design called for a special equipment order. This meant both extra expense and long delivery time.

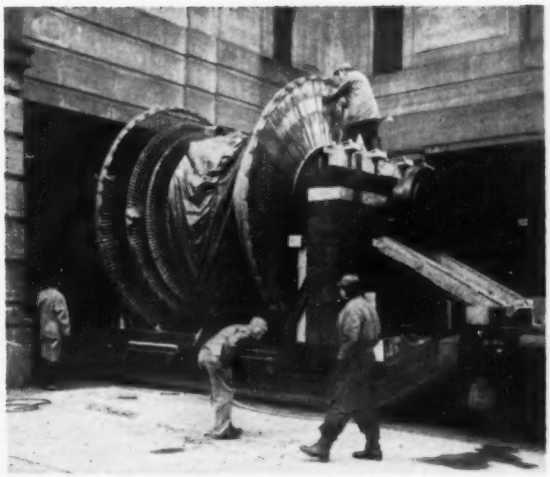
To keep outage time of this 165,000-kw generator to a minimum, it was decided to replace all the largest blades with a type currently manufactured. This plan had many complications. Blades in production today are longer than the original ones, so the turbine had to be adapted to receive any new spindle.

The rotor selected was four inches larger in diameter than the old one. So turbine shell definitely had to be bored out. Fortunately, it was thick enough to allow

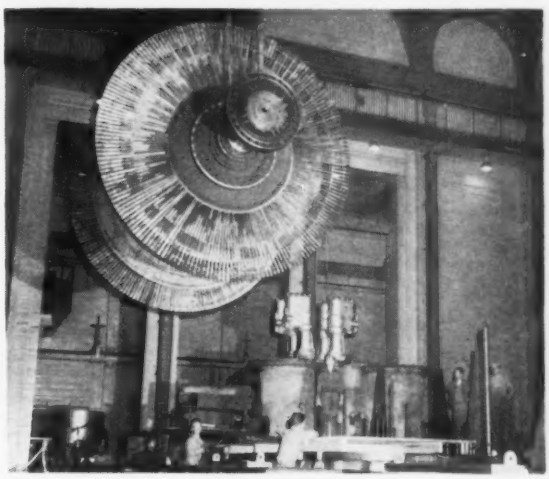
big to move by rail or roadway



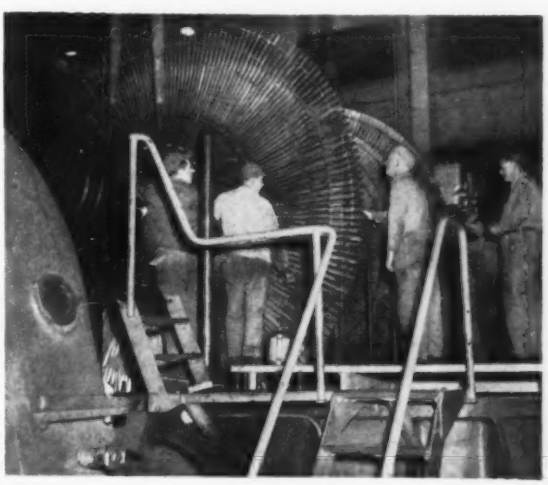
3 Cables and shoring are carefully examined before turbine-spindle assembly is hoisted from derrick to the flatcar



4 Spindle mounted on depressed-bed railroad flatcar enters the plant. Scant overhead clearance is given another check



5 Station overhead crane swings rotor and blades up from the railroad car and over toward the turbine for installation



6 Maintenance men gently ease the spindle into place on the turbine. Whole repair operation is finished on schedule

removal of enough of the metal to obtain a good fit.

Second problem faced was the matter of transportation. The spindle was fabricated in the Lester plant of Westinghouse Corporation. Highway and railway clearances were not enough for direct shipment of the 75-ton spindle. So transporting it part way up the Delaware River appeared to be the only solution.

A depressed railway flatcar brought the spindle to the Army Engineer's pier next to Fort Miffin. Then a sea-going derrick carried the spindle up the Delaware while the flatcar was brought around to meet it. Rotor was then reloaded and taken by railroad to the Richmond station. The whole move required a little more than five hours. Careful planning paid off by keeping outage time of this turbine to a minimum.

Right gage pressure keeps air tools operating at full power.

That's why it pays to . . .

Get and keep a better air system

By R J NEMMERS, *Ingersoll-Rand Company*

► ALMOST EVERYONE agrees that compressed air is a handy power service. It does many plant jobs that would otherwise cost more or couldn't be done at all. But, like everything else, compressed air costs money. So producing, distributing and using it the right way can pay big dividends.

What's wrong with the system? First, make the test shown above using gage equipped with a hypodermic needle. Pierce the hose next to the tool and read the pressure. This type gage does not leave an air leak when it's withdrawn.

To do a good job, the system must deliver the right pressure to tools running under full load. Anything less cuts performance. For example, increasing the pressure from 70 to 90 psi increases available power 37% for the average tool.

System overhaul is needed if tool air pressure is less than 80 psi. Some careful maintenance may do the trick if pressure is in 80 to 90 psi range.

Finding what's wrong with the system is half the battle. Three things can be at fault, either separately or in combination: first, too much leakage; second, too many restrictions to flow—too much pressure drop across the system; third, not enough compressor capacity.

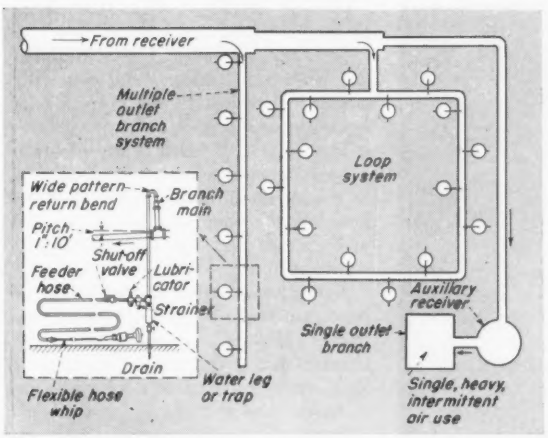
Leakage. How much air you can afford to lose is a relative matter. It depends on system size and air quantity. First measure the amount of air used during peak periods. Hook up a recording ammeter or wattmeter to the compressor drive. Time spent at each degree of load will be clearly shown on the record. Use this time record and actual air delivery (not piston displacement) to calculate the average air output per hour.

On a 2025-cfm compressor with five-step control, the record shows that a total of 85,556 cf of air is supplied over a 60-minute period. Load during this time varies from zero to full. From this data, the average air output is calculated to be 1426 cfm.

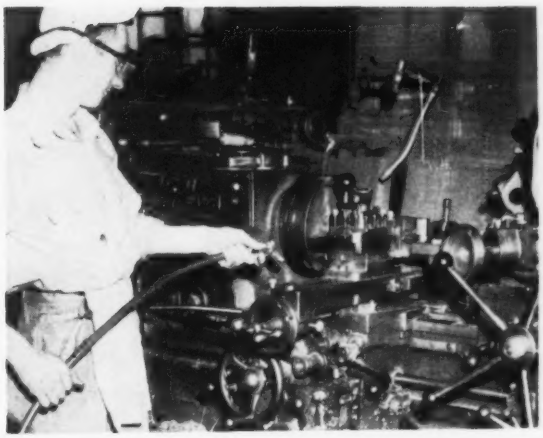
Then measure the amount of air lost. This must be done when no air is being used. That limits the test to a weekend, holiday or noon hour. Maintain normal pressure in the system and record the same kind of data taken for the average air use test. Next, calculate average air loss per hour.

When air loss is divided by air use, the result is a percentage measure of air system efficiency. If the loss is less than 5%, the hookup is in good shape. If it's between 5 and 10%, corrective maintenance will help. But if more than 10% of the air produced is lost, leaks are costing far more than it takes to run them down and seal them off.

Most air leaks are small but the cumulative effect is great. Look for leaks around valve stem packing, in the



SCHEMATIC of multiple outlet branch- and loop-air systems illustrating recommended feed line hookup to the branch main



OPERATOR uses air hose with an automatic spring-loaded air-outlet valve to blow metal chips away from work on the lathe

valves themselves and in valves on tools. Tools shouldn't be left under pressure on the line—but often are.

Check hose carefully. It can be one of the worst offenders. Standardize on good hose clamps. Leaks are frequent when makeshift clamps are used.

Check pipe joints carefully. If you're planning a new system, look into welded fittings. They tend to remain pressure-tight longer in service.

If you use blowguns, buy good ones designed for the service. Homemade types, like the one shown on the right, usually end up leaking air.

Install condensate separators and drains so your operators don't have to blow down the line to clear out accumulated water. Schematic drawing, above, has a typical hookup with water leg or trap to remove moisture.

Too much pressure drop? After the leaks are taken care of, check pressure at the tool again. If it's up to normal, you've corrected the trouble. If it isn't, record air pressure at the main receiver several times during periods of heaviest use. At exactly the same time, record pressure at the end of branches and at tools when the tools are running; then correct readings for gage errors.

If the pressure drop between main air receiver and the end of a branch is more than 5 to 7 pounds, it's too much. Pressure drop between end of branch and the tool should not be more than 5 pounds. With excessive pressure drop, chances are you're wasting more money from lost production than it would cost you to completely overhaul the air system.

If excess pressure drop is between the branches and the tools, the air hose is the most obvious place to look for trouble. It should be sized for a maximum pressure drop of 5 psi when the tool is running at full power.

Don't use hose longer than necessary to give the worker enough freedom of movement. If long lines are needed, use a larger size with a shorter light hose or whip at the tool. Then check the size of spuds, nipples and hose menders. Never install a restriction in the line smaller than the nipple put on the tool by the manufacturer.

If too much pressure is lost between the main air receiver and the end of a branch, again look for the most obvious restrictions. Mains are usually large enough. But branches and feeders are easily overloaded by the addition of new tools on the line.

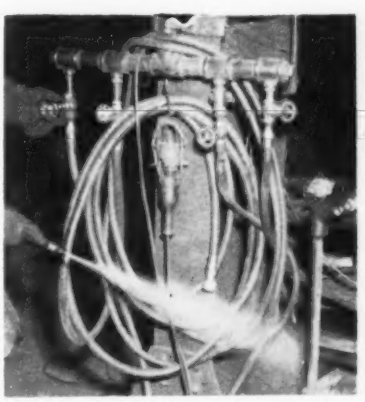
Main lines are sized for average air flow with a very moderate pressure loss of 3 psi or less. Branch mains and feeders are sized to carry the maximum expected flow at any one time. Pressure loss should not exceed about 3 psi.

If a line is undersized for the load it must carry, run another parallel line down the other side of the shop. Then connect the two lines together at the far end. Divide tool outlets evenly along the two sides of the loop. It gives two way flow to points of heaviest use and often corrects the trouble. Looping a system like this does more to improve it than any other one remedy. Schematic drawing, above, compares the branch and loop air systems.

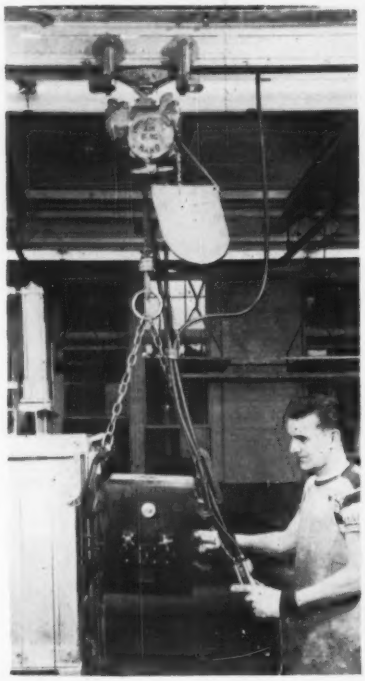
Run pipes as directly as possible to their destination. Avoid sharp bends by using long radius elbows and tees.

Sometimes there are heavy intermittent demands on the system—possibly at the end of a long line. This causes serious pressure losses. Best way to handle it is to install a simple air receiver as close as possible to the end

MAKESHIFT air valve used to clean up this foundry core leads to air waste



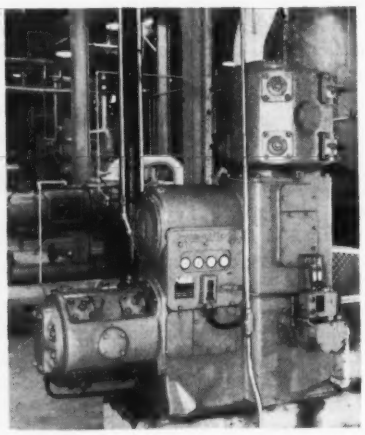
AVOID blowing water from air line. Use water trap and save 50 to 300 cf of air



AIR MOTOR is versatile tool for many plant lifting operations like this one

GRINDER with a flared cup-type wheel removing rough welds from a steel frame

CHIPPER also has many plant uses. Here the operator is pruning a steel casting



COMPRESSOR system must have enough capacity to handle all air tools used

Compressed air powers wide variety of tools

use. Stored air power is then available when needed.

System standards. For economical performance all air systems must meet certain minimum standards. Slope all lines in the direction of air flow. Use a minimum pitch of 1 in. in 10 ft.

Compressed air is cooled immediately after compression to remove the water vapor. But some water will always condense in the distribution lines. So separators and moisture traps must be provided at low points and dead ends in the system. Automatic traps make sure that moisture is drained. But install them where they can be seen or heard and serviced. Leaky traps can waste air unless discovered early.

Take feeders and other connections in the system from the top of mains and branches. Otherwise water condensed in the line will carry over into the tools. There it interferes with lubrication, causing maintenance costs to soar.

Include strainers and lubricators in all tool outlets. Empty and clean the strainers frequently and keep all lubricators filled.

Have a shutoff valve handy for each hose connection. Provide a bridge if hose must cross vehicle roadways. Keep hose off the floor and away from oil and grease. Use brackets to carry it when not in use.

Compressor capacity. Only after it is certain that the air distribution system is adequate can you positively determine that a compressor capacity is large enough or too small for the job at hand. And at this stage it is a simple matter.

If pressure at the tool, when the tool is running, is still less than 90 psi after leaks and flow restrictions are removed, then there isn't enough compressor plant for the number of tools in use. This low pressure will also show up in the main receiver. If this is the case there are several courses of action open depending on the requirements of the individual system.

You can install a new compressor large enough to handle the deficit plus a reasonable allowance for expansion.

Or the entire compressor plant can be examined with an eye to replacing one or more of the older less efficient compressors with a larger modern unit.

All factors have to be considered before making a final decision. Power consumption, cooling water use, maintenance, possible power factor correction, etc, may combine to make a completely new compressor plant cheaper in the long run.

Preventive maintenance. Once a compressed-air power system is in good shape it's easy to keep it that way with periodic checks by the plant operators. Remember that no fuses blow when an air line is overloaded. The result is loss of production, increased worker fatigue, lower quality work and more expensive compressed air. Keep your system up to par by:

(1) Running air leakage tests on a regular schedule for all tools.
(2) Making random checks of tool air pressure while the tools are running.
(3) Checking automatic traps at regular intervals for leaks
(4) Examining all lines for ability to take heavier load when adding tools.

Remember when changing or extending your present air power system that the installed cost of the next larger size pipe is not much greater than the minimum size called for. It pays to plan for future increased air demand.

Three steps to corrosion-inhibitor control

By **A J RISTAINO**, *U.S. Naval Engineering Experiment Station*

► SOLUBLE-OIL corrosion inhibitors are being used to protect cooling systems of internal-combustion engines. They are said to be easy to handle and to have superior quality in halting corrosion in bimetal systems.

Estimating the amount of oil in a closed water cycle becomes important to insure proper balance, prevent corrosion and oil fouling. A 1% concentration by volume is generally recommended. Mineral oils processed to emulsify with water are usually used.

The test to determine amount of soluble oil in the emulsion involves demulsifying a measured quantity with an alkaline earth salt, Fig. 1, 2. The oil then floats to top of container. Height of oil layer is compared with standards or measured directly, Fig. 3.

Soaps and detergents are frequently used to make the corrosion-inhibiting oil emulsion or suspension in water. The emulsion breaker demonstrated is calcium chloride. This destroys the emulsifying soaps the same as calcium consumes soap in hard tap water. The salt also increases surface tension of the water. This serves to destroy the emulsion.

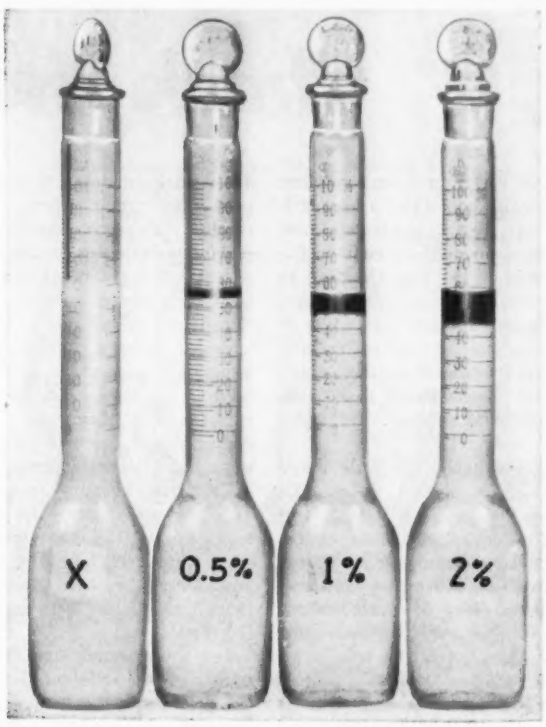
It may take two or three hours for the oil to float to top if the emulsion has been in engine service a long time. Oil in a freshly prepared emulsion should coalesce rapidly.

The glassware illustrated are modified Babcock bottles. Any similarly shaped bottle or volumetric flask can be adapted to the test.

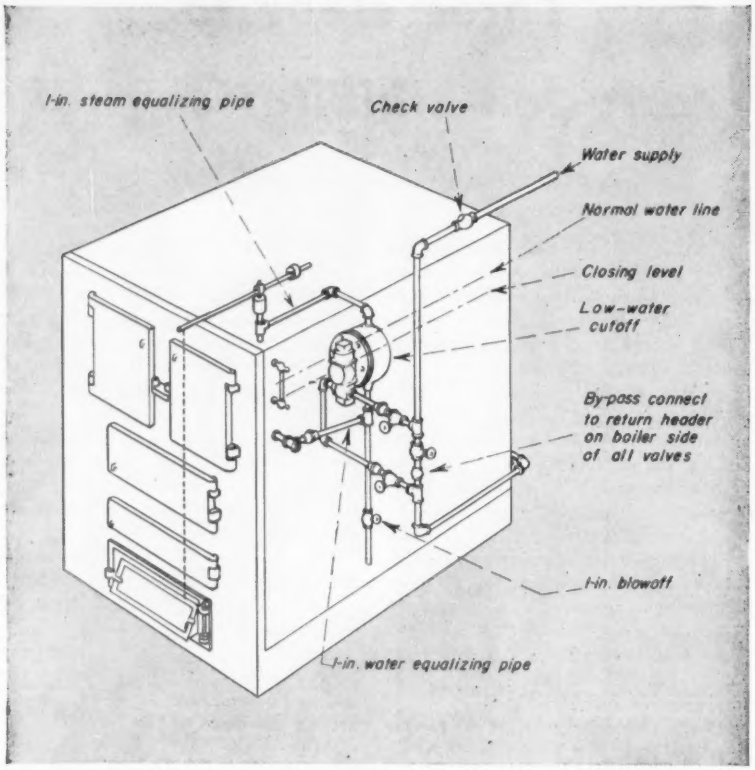
NOTE: The opinions and assertions above are those of the author and are not to be construed as official or reflecting the views of the Navy Department or of the Naval Service at large.

1 Pour 50 milliliters of cooling-system fluid into suitable graduated flask

2 Add 3 grams of calcium chloride. Then stopper flask, shake vigorously

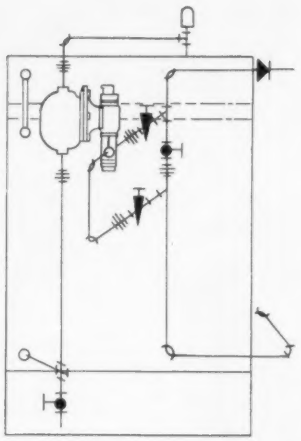


3 Let oil separate. Compare height of oil layer with standards containing measured volumes of water and free oil



1 Low-water cutoff, correctly installed above, must have water and steam space-equalizing lines connected right to get true boiler water level in float chamber

Avoid these 4 common



2 Water-equalizing line led to bottom of boiler gives false low-water signal

Check the hookup for

► TOO MUCH WATER in a steam-heating system will raise hob with its heat output, but isn't likely to damage the boiler itself—provided, of course, the safety valve is on the job. Opening at 15 psi will relieve water pressure before the boiler can be hurt. But if water continues to enter the boiler with no one around to detect it, there's apt to be a mess in the boiler room plus possible damage to equipment or materials in the area.

On the other hand, too little water during firing, is a real killer. No boiler, large or small, will last long under low-water or dry-firing conditions. Unattended, the boiler hasn't got the chance of the proverbial snowball.

Since the majority of steam-heating boilers are automatically fired, and therefore unattended in the true sense of the word, it's logical that a protective device be used to forestall damage from low water. Today's low-water cutoff device is designed to do just that. It's electrically wired in series with the burner or stoker motor and interrupts the circuit when boiler water reaches the lowest safe-operating level. An automatic water feeder, set to admit water to the system when boiler water is slightly above low-water cutoff setting, is a good adjunct to cutoff.

Boiler damage would seem almost impossible with these devices to ride herd on low water, but, unhappily, this isn't the case. Hundreds of boilers are damaged and destroyed each year despite their low-water cutoffs.

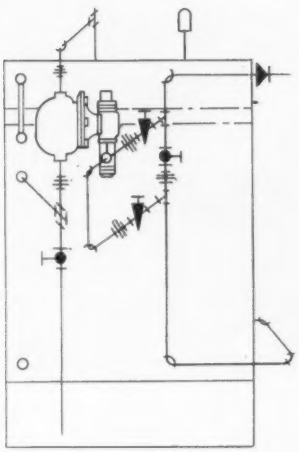
Two main factors are responsible: (1) The cutoff gets little or no maintenance and (2) the cutoff isn't installed properly. The first factor is far and away the most common cause, though the latter gets in some hard licks, too.

Low-water cutoffs are generally well built and are reliable. They'll protect the boiler provided they're regularly checked and serviced. However, this end of the bargain must be upheld by the person responsible for the boiler's operation. Too often, after a boiler is damaged, examination shows the cutoff's float chamber clogged with mud and sediment. This holds the float in "up" position so it *can't* drop and break the burner or stoker motor circuit. There's no excuse for letting a cutoff get in this condition. Blowing out the float chamber, even once a month, would keep it clear. And checking the float, linkage, feed valve (if any) and circuit wiring a couple of times a year would save a lot of grief.

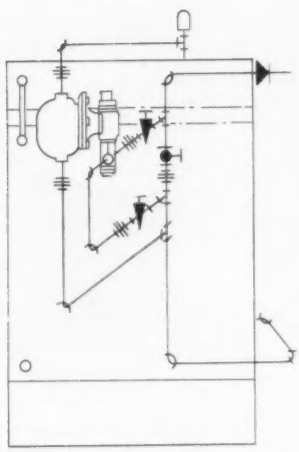
Improper hookup, aside from preventing good cutoff, can mean a law violation in those cities and states which have adopted the ASME *Low Pressure Heating Boiler Code.*

Correct hookup is shown in Fig. 1. Whether they're steel boilers with independent water columns or cast iron boilers with a water glass in the first section, it's important to connect the water-space equalizing line at a point about six inches below the water glass (or above the boiler's firebox) where

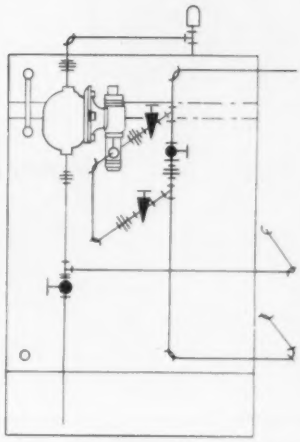
piping mistakes; service your control regularly to protect boiler



3 Connecting cutoff to steam flow line may hinder needed control function



4 Water-equalizing pipe to feed line gives false level, tricky float action



5 Water-equalizing line led to indirect heater tapping also gives false level

your low-water cutoff

By R C BELLAS
Assistant Editor

there's a large volume of water and slow circulation.

A common error shows up in Fig. 2. Here, the equalizing line is connected to the lowest part of the water space. When the boiler begins steaming, water-leg circulation creates a downward pull through the equalizing line. This permits the float chamber water level to be anywhere from 2 to 11-in. below the level in the glass. When this happens, control gets the "low-water" signal and immediately shuts down the burner or stok-r. A few shutdowns like this and the operator thinks the control is haywire. He by-passes to manual feed (if it's a combination unit) or, he blocks the relay in the closed position thus eliminating any protection the cutoff might give him.

Another error, Fig. 3, is in connecting the steam-equalizing line to a steam flow line. When the boiler steams, velocity through this line pulls the water level in the float chamber higher than the level in the gage glass. If boiler water level drops too low, float may not drop with it to stop firing equipment.

Still another common error, Fig. 4, shows the water-equalizing line connected to the boiler feed line. This also can give false water level and erratic float operation.

Connecting the water-equalizing line to an indirect heater tapping in back of the boiler, Fig. 5, can cause trouble. Aside from giving slow equalization in the float chamber, it causes false level float action. Boiler water circulates rapidly around the indirect heater tapping, making it difficult to reproduce true boiler water level in the float chamber.

Water- and steam-equalizing lines from a cutoff float chamber can be connected directly to the equivalent lines on boilers having independent water columns. This doesn't conflict with the ASME code because it simply duplicates boiler water column conditions in the cutoff float chamber.

ED. NOTE: *Data furnished by McDonnell & Miller, Inc.*

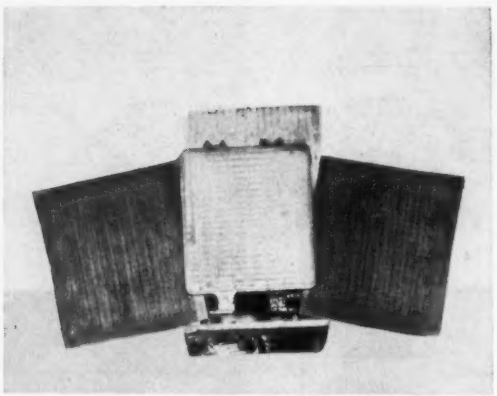
Important

Never connect a steam-flow line to the steam-equalizing piping of the boiler water column. This will not only show an incorrect water level in the gage glass, but will be a violation of the law in those cities and states which have adopted the ASME *Low Pressure Heating Boiler Code.*

Connecting steam- and water-equalizing lines from float chamber of a low-water cutoff to steam- and water-equalizing lines of the boiler's water column only results in addition of another water column to the boiler. This practice meets with code approval because it provides accurate reproduction of boiler water level in the cutoff's float chamber; insures positive control action when needed.

REMOVING CELL with lug handle while standing on chain clamps that hold jar

With right tools and materials on hand . . .



OLD SEPARATORS were carefully pulled out from between plates with cell turned upside down on the repair bench

How we replace storage-battery separators

By **DWAINE BECKLIN,** *Electrician*
Rural Cooperative Power Association, Elk River, Minnesota

► VOLTMETER TESTS showed the presence of shorts in the separators of our 60-cell battery at Milaca Diesel Plant of the Rural Cooperative Power Association, Elk River, Minnesota. This lead-acid-battery bank supplies power to operate oil circuit breakers. Battery had seen 7-yr service and, although a life of 15 to 20 years is not unusual for battery separators in this service, it looked like shorts were caused by small particles dislodged from the plates, not by impurities in the battery water. (Water containing impurities, such as iron, cobalt and manganese, start chemical reactions that attack separators.)

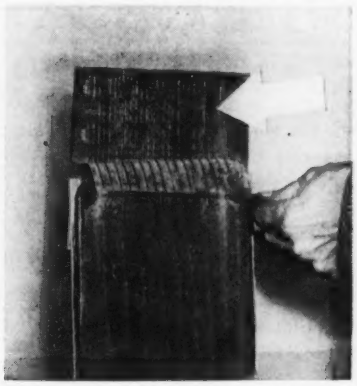
During normal life of battery, some small particles of material come loose from the plates. Most of them drop to the bottom of the jar, forming sediment in the space provided for it. However, some particles are trapped between the plates and the separators. Pressure of the plates and movement of the electrolyte cause these particles to wear through the separators and penetrate the pores intended for passage of electrolytic current.

Early battery separators were generally made of wood and these are most subject to trouble. Later, perforated hard rubber was used. Rubber separators have been steadily improved. Some use cotton threads embedded in the rubber to make them porous; others have small pores to prevent particles from penetrating them, yet enough pores to permit circulation of the electrolyte.

We decided to overhaul the cells. Our first move was to get the advice of the battery manufacturer. Their representative came out to our plant and assisted us in getting started on the right foot. We obtained the right tools, which made the job easier. (It took us about 1½ man-hours per cell.) Plans called for a complete replacement of rubber separators with the latest composition-rubber type, and a 20% replacement of glass separators. We had 1300 specific-gravity electrolyte on hand to take care of what would be lost. All personnel wore goggles and plenty of soda water was available to neutralize spilled acid. As soon as we removed a cell from the battery it was vented—and vented again each time a flame was applied in order to prevent an explosion of the gases given off.

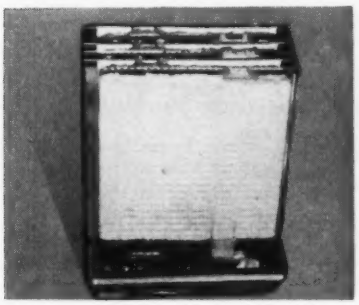
Since it was necessary to keep the battery constantly in service, six cells at a time were jumped by a 12-volt

battery-separator replacement is quick and easy

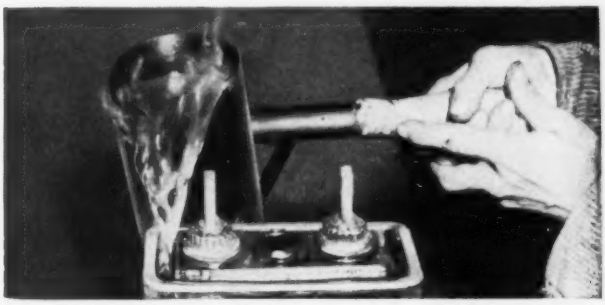


HOLES that caused shorts in old separators were fairly large in some of cells

WASHING CELLS with water hose at 10 pounds pressure to remove debris formed by dislodged plate material, decomposed separators



NEW SEPARATORS in place in cell. We found the plates in good condition



POURING COMPOUND around top of cell to seal jar. Compound was smoothed with a torch; posts cleaned and coated with fresh grease

automobile battery. We removed these six cells from the bank, overhauled and replaced them without interrupting battery power.

Plate assemblies were removed from the cells by heating an old knife blade and using it to cut the sealing compound from around the cover. To remove assemblies we used tools to grip the cell and terminals. Plate assembly was placed upside down on work bench and separators pulled out. All rubber separators and damaged glass separators were discarded. The electrolyte was poured from the opened cell jar into a glass container.

Plates were washed with water hose at about 10 lb pressure to remove any loose material. We installed new composition-rubber separators, and a few glass separators where old ones were damaged. (The plates proved to be in good condition.) We placed a wet rag over the plates to keep them moist while out of the jar, and prevent them from heating. Next, we washed out the battery jars.

Old electrolyte was poured back into the jars and lost portion replaced by the 1300 specific-gravity acid which brought solution up to 1250. New separators absorbed acid and lowered specific gravity to about 1220.

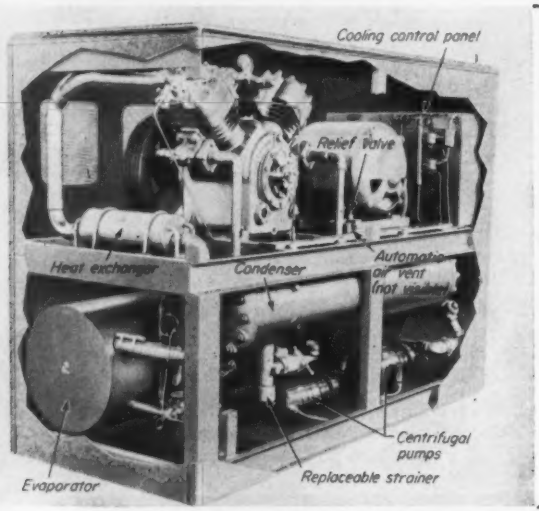
Plate assembly was then replaced in the jar. We packed string sealing compound between the jar and cover, removed moisture from cover by wiping it with paper towels and poured melting sealing compound around the cover. (A small amount should be poured around the cover and allowed to cool to prevent hot compound from melting string compound and running down inside the jar.) After the cover was poured full, we smoothed the compound by applying a blow torch for a few seconds.

We removed old grease from around battery posts; then applied new battery grease and smoothed it with the torch. Post bolts and connecting straps were washed in soda water to neutralize any acid on them. Straps were cleaned with steel wool at connecting points. Battery was then reinstalled in the bank.

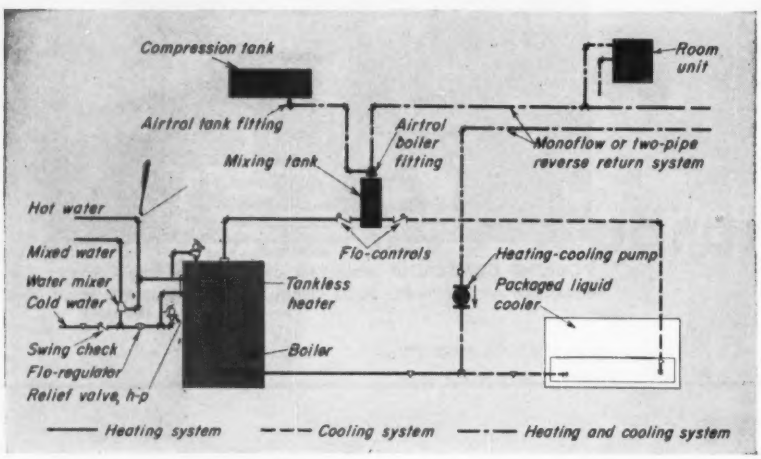
After overhauling and reconnecting all cells, we put the bank on high charge until specific gravity remained steady for eight hours. We corrected specific gravity to read 1220 in each cell by removing electrolyte and substituting distilled water to lower the specific gravity, or 1250 acid to raise it.

OPERATORS' NOTEBOOK 110

Today, air conditioning

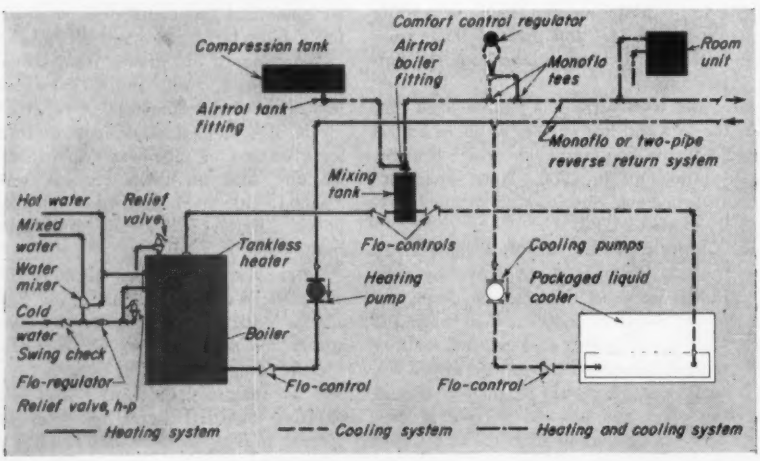


Packaged liquid cooler. Conditioning air in industrial plants and office buildings today is a year-around job. Here's a packaged liquid cooler designed for this dual service. Evaporator is under compressor to lower center of gravity. Compressor position assures no slugging damage and allows non-recycling pump-down. That allows you to pump liquid refrigerant out of chiller and into condenser each time master temperature controller has been satisfied or master switch thrown. Compressor on top is normally in warmest part of room. This tends to prevent gas from condensing in crankcase, doing away with crankcase heater. Condenser below compressor retains refrigerant as gases condense at coldest spot. (Condenser usually has average lower temperature than compressor or chiller. Chiller won't absorb refrigerant vapor from the condenser or compressor, even though in coldest area of room.) This prevents slugging of liquid refrigerant and oil into compressor cylinders at start-up. — *Courtesy, Bell & Gossett Co.*



One-pump heating-cooling

Liquid cooler, above, supplies the cooling capacities needed with either manual or automatic control. When interconnected to heating system, left, manual or motorized valves installed in bypasses permit same pump to be used for both the heating and cooling cycle. But be careful that the water temperature is reduced to less than 100 F before the cooling system is started. If not, you may damage the chiller or the compressor. Here the mixing tank and venting system helps remove air from the system water. Mixing tank permits using a single compression tank for both heating and cooling shown here.

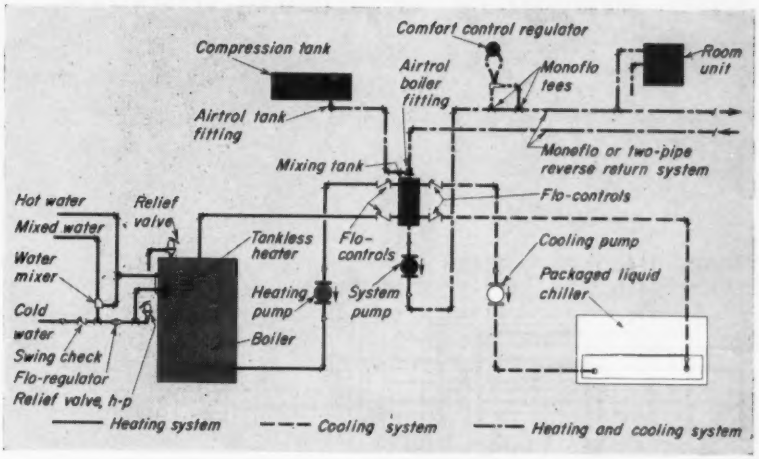


Two-pump heating-cooling

Cooler has automatic change-over from winter heating to summer cooling. No hand or motorized valves are needed. One pump circulates boiler water for heating, other circulates water from chiller for cooling. Both pumps are sized for different heads needed in the heating and cooling circuits. Diagram shows comfort control for change-over from heating to cooling. Control reduces system water temperature on heating side as outdoor temperature increases towards point where cooling is needed. When cooling cycle begins, water goes below 100 F. If no outdoor control, keep water to chiller below 100 F.

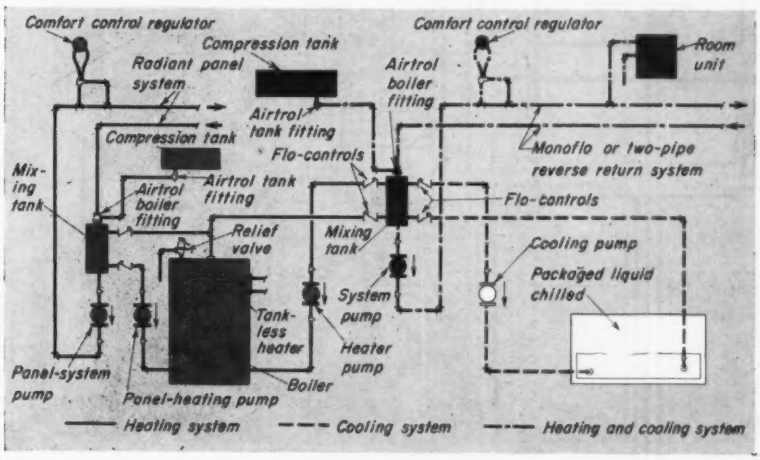
means cooling and heating

By STEVE ELONKA
Associate Editor



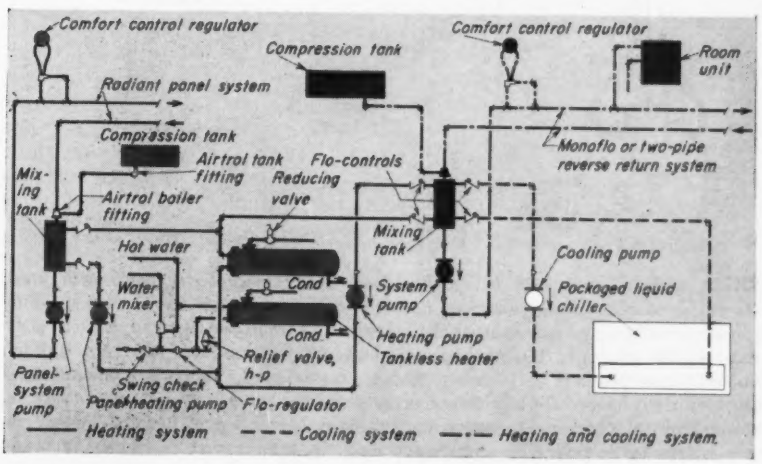
Three-pump heating-cooling

Mixing tank in this system acts as reservoir for either hot or chilled water. It's also a collecting point for air. Water from mixing tank is circulated through the system by the third pump. Three-pump method offers many advantages over one- and two-pump systems in reduced chiller pump size, lower power consumption and a higher degree of automation. You don't need manual or motorized valves for controlling or balancing. This system shuts down all equipment when outdoor temperature reaches comfort level. Control modulates water temperatures during heating cycle for maximum comfort.



Dual heating-cooling

With this system you can increase the application scope of heating-cooling systems by combining panel heating with heating-cooling convector units. Here you have two mixing tanks and two compression tanks. The panel heating system has two pumps, making five in all. This dual system provides a degree of control which achieves the utmost in comfort conditioning. For example, in the spring and the fall, it will provide heat on chilly mornings and evenings. Then, during the warm afternoons, it will provide cooling. All this is done automatically with the built-in electrical controls in the system.



Dual conversion system

On installations where only steam is available, it's possible to use steam heat exchangers for both domestic-water heating and space heating as shown in diagram, left. But here the cooling is also provided by a packaged liquid cooler as in the other diagrams. In your existing two-type steam heating installations, you may possibly be able to replace old radiators with modern heating-cooling convectors. You can use water as the conveying medium. Each room, office or area can be individually controlled to meet the heating and cooling requirements in this way. Converter takes the place of a boiler.

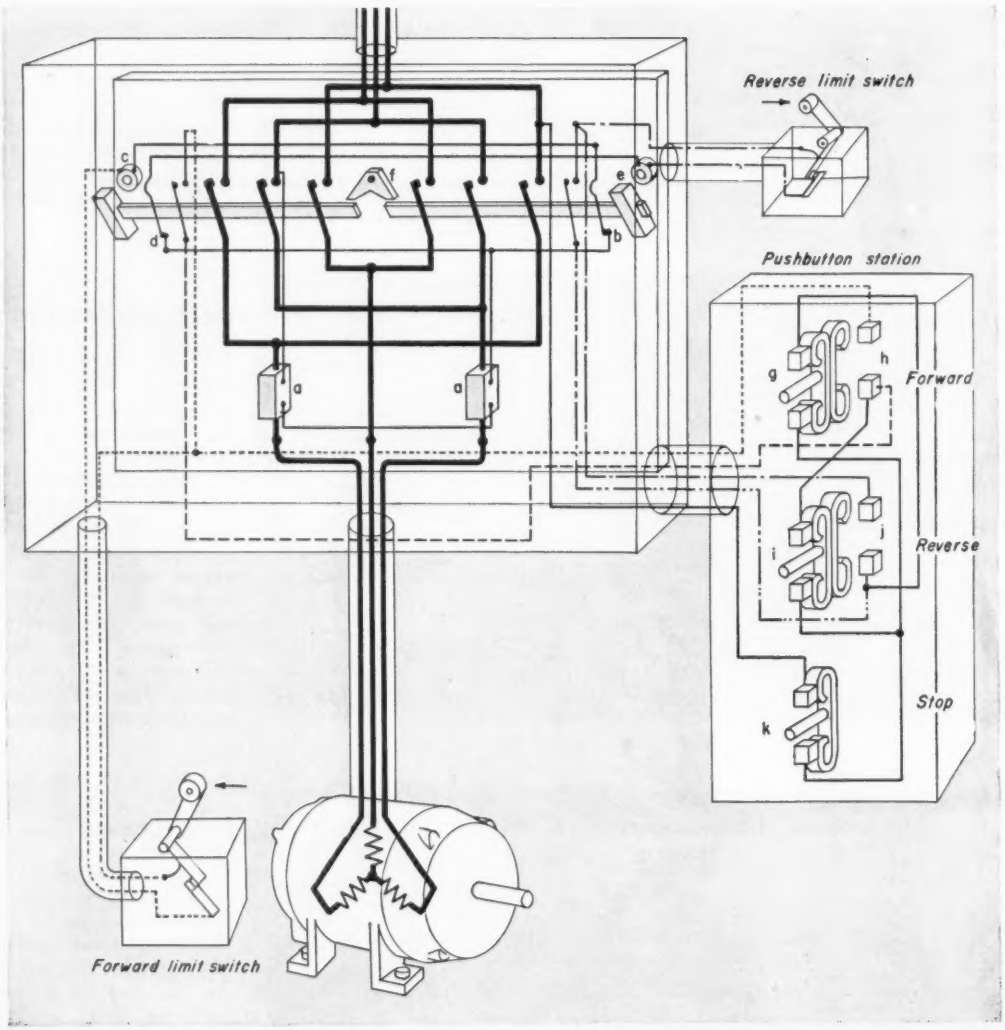
Plant

Electrical

Fact File

NO. 16: REVERSING CONTROLLERS

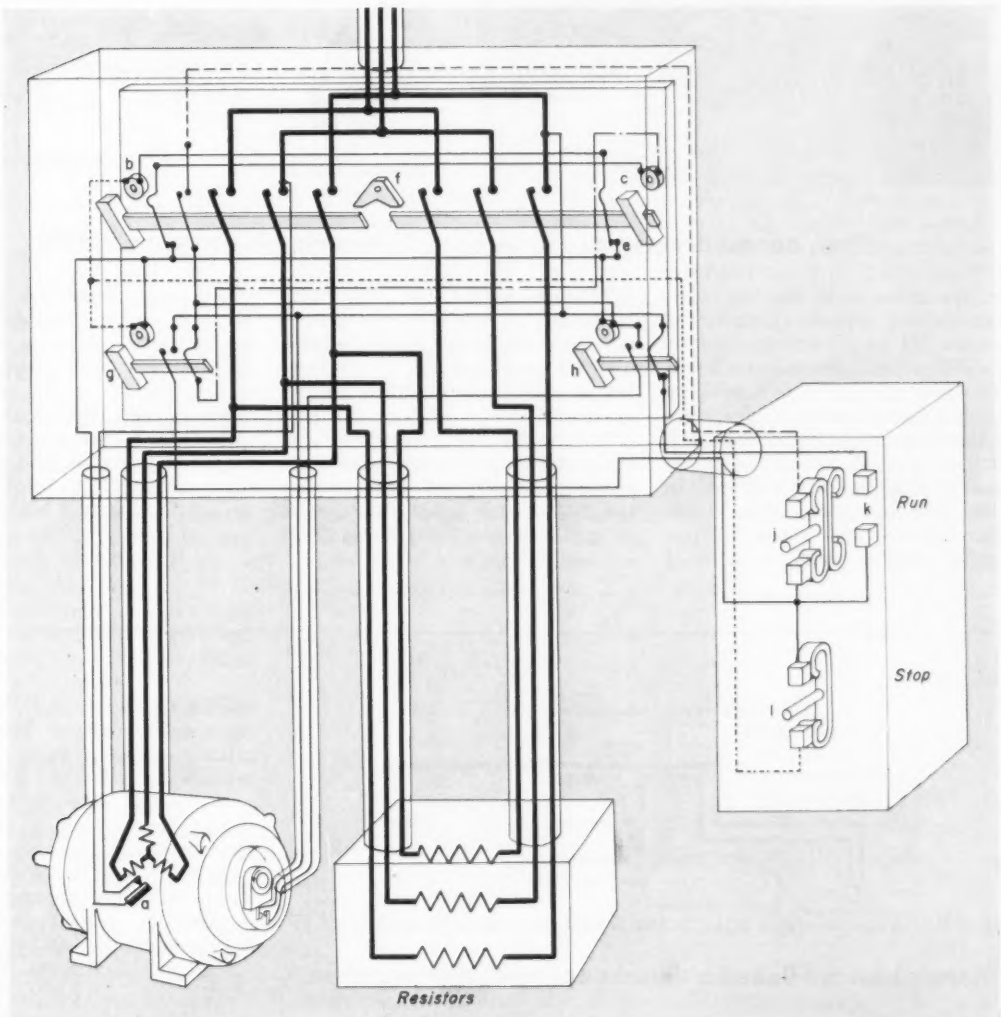
Controllers for reversing and plugging 3-phase motors



TYPICAL REVERSING CONTROLLER such as may be used for conveyors, small elevators, machine tools, hoists, etc. Motor is shut off automatically when machine trips limit switch, and is started manually to run in opposite direction. Controller has two sets of contacts, those on left for *forward*, on right for *reverse*. Control circuit goes through overload relays *a* and interlock *b* to forward coil *c*; via interlock *d* to *reverse* coil *e*. Electrical interlocks *b*, *d* and mechanical interlock *f* prevent either contactor from closing while other is energized. Circuit to *forward* button goes through *stop* button *k*, then contact *i* of *reverse* button. Thus pushing *reverse* opens *forward* contactor and closes *reverse* contactor. Similarly, circuit to *reverse* button goes through contacts *g* of *forward* button. If reverses are frequent, temperature relay may be used.

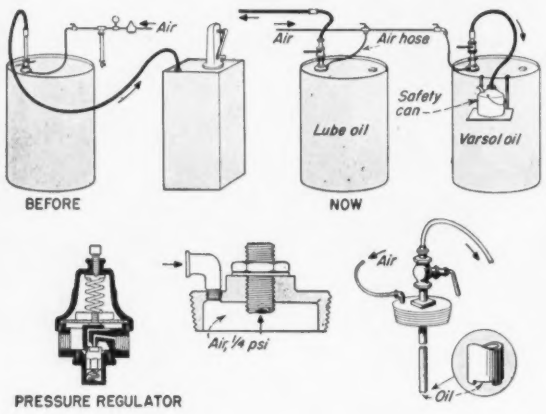
► MAGNETIC REVERSING CONTROLLER for 3-phase motors is used where motor must be reversed by remote or automatic control. Controller changes phase sequence by switching two legs. Plugging is decelerating motor by reversing its torque and shutting off power just before it starts to rotate in opposite direction. Plugging relay, attached to motor, is closed only when motor rotates in forward direction. Circuit shown is designed so motor can't be accidentally started if it's rotated by hand or by machine which is driven.

By **NORMAN PEACH**, *Assistant Editor*



PLUGGING CONTROLLER applies reversed torque to rotor to bring it to quick stop. Resistors may be used to limit motor current. Over-temperature relay *a* usually is used instead of over-current relay. Interlocks *d*, *e*, *f* work same as in reversing controller Pushing *run* button closes control circuit through NC contacts of relay *h*, and contacts *k*, *l*, energizing coils of *run* contactor *b* and auxiliary contactor *g* which maintains circuit through its NO contacts. Forward rotation of motor closes plugging relay contacts *i* and releasing *run* button closes *j*. Auxiliary relay *h* is energized through NO contacts of *run* contactor and is maintained through *i*. Pushing *stop* button de-energizes *b* and *g*, closes circuit to reverse coil at *g*. Reversed power slows down motor until it stops. Plugging relay contacts *i* then open, shutting off the controller.

Up-to-date PRACTICAL IDEAS *to lick some of your*



Now, our oil drums can't blow up with this aluminum rupture disk

Ever see an oil drum blow up while being emptied with air pressure? I once saw 125 psi put into the drum by a careful operator who was in a hurry.

To make this operation safe, I remove the spring and diaphragm from the air-pressure regulator, sketch. Then I cut out a round disk from ordinary household aluminum foil—and that's it, photo. Disk ruptures at about 7 psi.

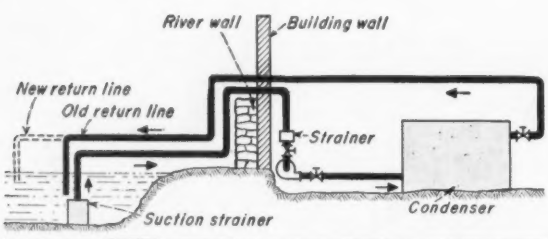
Our lube oil and Varsol oil (for cleaning printing rolls) is delivered outside our engine room. Oil drums are hooked up to a ½-in. line directly to a large storage tank inside the building. We then hook the oil discharge line to the drums and blow oil into the storage tank.

This low-pressure ruptured disk is so handy that I use it in our printing department to safeguard a quart glass container of offset powder. Jar is rated at 50 psi—but our line pressure is 125 psi, then reduced to 6 psi to jar.

Both engine-room and printing department devices have been tested by our insurance carrier, State labor department and safety committee. They all passed it.

When I need higher than 7-psi pressure, I use a heavier wrapping paper. Photo shows conical head of the regulator machined off. Rod is passed through lower part of head so it can be removed quickly without a wrench.

R BOETTINGER, *Englewood, N. J.*



Here's how we licked a diesel cooling-water problem

New refrigeration plant used cooling water for its ammonia condensers. Water was taken from a river with a high masonry bank that couldn't be broached. So water was piped over the bank through an inverted U-shaped pipe, sketch.

Area also had winter trouble with freeze-up of surface and near-surface water. To avoid freeze-ups, plant engineers piped the return water from condensers to a point near suction for cooling water. Idea was to circulate the warmer discharged water near suction to help prevent freeze-ups. Engineers also figured this would keep strainer plate clean.

What happened? Well, pump was running OK mechanically, but failed to pump water. Reason? Pump was circulating air mixed with water, until pressure finally dropped to zero. If you put your ear close to the pipe, it sounded as if pump was circulating shock absorbers. Solution was to reroute the line further from suction as shown. After that the pump met service requirements without the disturbed water entering the suction point.

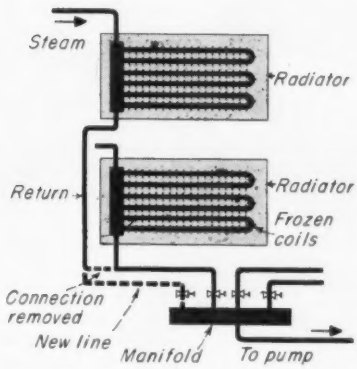
C M JONES, *London, Eng.*

Never . . . NEVER . . .

use oxygen to blow oil lines. CO_2, yes; compressed air, yes; but not oxygen. Even slight oil left on pipe threads will explode violently when contacted by oxygen. Use oxygen for welding only—and you will live a great deal longer.

operation and maintenance problems

STEVE ELONKA, *Associate Editor*



No more frozen coils

Our indirect heating system has two stacks of fin type heating coils, one above the other. Lower coils of lower stack froze several times and ruptured.

Coils were new, guaranteed for one year. So manufacturer repaired them. Next winter, lower coils ruptured again. But the guarantee was up, so we paid for repair. That's when I decided that return lines were not connected right.

As sketch shows, return line from upper radiator ran into lower radiator return. It seemed to me that the 1½-in. return line from there to the manifold was too small for condensate from two stacks. That would cause water to back up in lower coils and freeze.

I removed the connection and ran the return from upper radiator directly and independently to manifold. That change ended our freezing problem.

J W BLAKE, *New York City*

I use horseshoe nails

One of the most useful items for a millwright or maintenance foreman is a few pounds of horseshoe nails. You won't find anything handier for leveling a machine when grouting to the foundation. Just place a few nails under the frame at various places. Because horseshoe nails have a head and are tapered and flat, they act as small wedges.

By tapping the nail with a hammer and watching your leveling instrument, your machine is gradually brought to a perfect level. After grouting is complete, chisel off the nail heads, leaving the metal-to-metal between the frame and the rough foundation.

F L GILLMOR, *Albany, N. Y.*

What would you have done?

Oil breaker in one of our hydro stations was giving us plenty of trouble. It failed to open recently, which cost my firm about $200,000 in damages. Trouble was from mechanical binding. We made tests and found that it took a 75-lb pull on the trigger to trip the breaker.

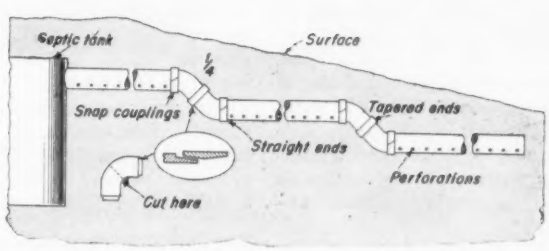
Manufacturer sent a trouble shooter up from the States. One of our own engineers worked with him for almost a week.

I happened to visit the plant and became interested in the problem.

Because I've run into that headache before, I had a fair idea of what was wrong. First, I asked for some fine tissue paper. That brought lifted eyebrows and plenty of attention. Then I asked for Prussian blue. I coated the contact faces of the trigger, latch and roller with the blue; then inserted the tissue paper and pulled on it to wipe off the high spots and expose them. It was these high-pressure points that caused the binding.

One of our mechanics got busy with a small portable grinder. He also did a little shimming. After that, the oil breaker worked like a charm. It tripped at 23 lb and with only one-third the former trip current. What would *you* have done?

L MCWILLIAMS, *Shawinigan Falls, Que.*



We solved drain pipe problem under sloping ground level

Nine lengths of perforated fiber drain pipe had to be laid. Gradual slope of ground surface gave us a problem. If we ran piping straight out from septic tank, it would be too close to the surface after four lengths.

It wasn't practical to slant the drain pipe down in one continuous line because the sewage had to be absorbed by the soil along the way. Problem was solved by cutting elbows in half and joining the outside tapered ends with tapered couplings. The cut ends were straight, so we used snap rings to hold them to the straight pieces of fiber piping. Leakage at joints was no problem. Main objective was to hold ends together so piping gradually stepped down the slope under ground level.

B W BRIZZIE, *Wassaic, N. Y.*

Turn page for more Practical Ideas ►

Begins on page 122

Here's your trick of the month

We redressed the badly bruised shaft of our 10,000-kva hydro generator in place. That saved high cost of pulling the shaft from its rotor and sending it to an outside shop for machining. As photo shows, our mechanism is makeshift. We first tried the rig on a smaller unit to prove job could be done.

Main elements have a 34-in. diameter V-grooved wheel, cut from 2-in. steel plate. A ⅜ x 14 in. bronze casting with flange was adapted to the wheel. Flange acts as the bearing on true section of shaft below thrust-collar location. Entire mechanism rested on the shaft's shoulder. Grinding unit, with cross and vertical-feeds, was attached to a bracket, photo. Rig was turned about generator shaft by an air-shaft drill at 30 rpm.

Insulated slip rings were attached to the underside of the wheel to pick up electrical supply for the motor. Job was a complete success.

With some refinements, and a more rugged design, there's no reason why larger shafts cannot be turned down or ground in this way.

L McWILLIAMS, *Shawinigan Falls, Que.*

Sure-fire way to match holes

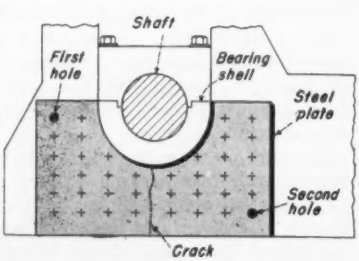
An overloaded engine frame cracked through the main bearing jaws. Because crack was opening wider daily, we had to do something drastic. That large engine cranked out all the power for thousands of men on a large construction job.

Solution was to strap a heavy plate over the crack to hold casting together. Steel plate was cut to fit side of casting, then heated and formed to hug casting. Instead of drilling the many holes to stud diameter into steel plate as the superintendent ordered and then scratching hole locations through these holes onto casting, I did this:

Placed plate against casing, drilled two holes in opposite corners to tap drill size, sketch. Then I removed plate, tapped out the two holes in casting and reamed out the two holes in plate to stud diameter size.

Plate was then bolted to casting and all holes drilled to tap hole size. After removing plate, casting holes were tapped and plate holes reamed. They fit perfectly. I've seen mechanics do a lot of unnecessary work of filing holes to make them match because they didn't think of this simple and sure-fire way.

H B McDERMID, *Long Beach, Calif.*



Handy jar opener

Take two old rough files or rasps, fasten them at about 30-deg angles from each other under a shelf or table, sketch. You can open any stubborn screw type bottle, jar or can lid regardless of size.

By exerting a little pressure on container with the lid against both file ends, you'll have both hands free to turn the jar. Also, the contents won't spill because container is right side up. Be sure to place the cutting edges of the files in opposite directions.

J VEITCH, *Pottstown, Pa.*

Turn page for more Practical Ideas ▶

Efficient hot line insulation is lightweight, easy to handle

Specially designed for hot lines operating up to 400°F., Armstrong Armaglas* Pipe Covering goes on fast, provides extra-efficient protection. Armaglas is made of glass fibers bonded together with a heat-resistant resin; it has a density of only 7¼ lbs. per cubic foot for light, easy handling. The resilient fibers mesh together at joints to give unbroken, continuous protection.

Armaglas Pipe Covering comes in 3′ sections for pipe sizes up to 33″ and copper tubing up to 6″. It is available with a variety of interior and exterior type jackets.

Armaglas Pipe Covering is one of the many fine products in the complete line of Armstrong Industrial Insulations. Armstrong also offers you a contracting service, geared to install these products efficiently.

Armstrong INSULATIONS

for temperatures from −300° F. to +2800° F.

*Ⓡ ARMSTRONG CORK COMPANY. MANUFACTURED BY OWENS-CORNING FIBERGLAS CORP.

Free Booklets

Armstrong Armaglas Insulations (data sheets)

Armstrong Armatemp* Block and Blankets

Armstrong Armaflex®, a Flexible Pipe Insulation

Armstrong LT Cork Covering for Cold Lines

For full information send for free literature. Write to Armstrong Cork Company, 2307 Riggs Ave., Lancaster, Pennsylvania.

*TRADE MARK

More PRACTICAL IDEAS

Begins on page 122

This tool measures bolt stretch accurately

We designed and built a tool to show accurate stress on our turbine-case bolts and studs, photos. We've had trouble stemming from bolts with too much, or too little, stress caused by inaccurate layout. Since we stretch our bolts with heat, and they must cool before being measured, these errors cost us valuable time.

All our turbine bolts have one thing in common—eight threads per inch and nuts tapped for a 1¼-in. eyebolt. So tool's protractor disk has 62 graduations, each representing 0.002 in., allowing a total of 0.124 in. on a full turn of the movable protractor leg. We figure an error of 0.001 per revolution is not critical.

Turbine bolts vary in size from 2½ to 4½-in. diameter. The OD of nuts vary correspondingly, so the tool must be adjustable. Protractor arms are slotted to allow adjustment to fit each nut size. On larger nuts we simply transfer layout lines down the nut with a scale.

Centering plug is turned a few thousandth's smaller than the tap drill size for a 1¼-in. eyebolt. It's turned to 0.375 in. diameter where it fits in the protractor disk. Top has a 5/16-in. thread for the locknut. Locknut has a bale on top for handling the tool easily. Center hole in protractor disk is a ⅜-in. reamed hole. Legs are a neat sliding fit in slots of protractor arms. They are locked in place with 10-32 screws and washers. Legs are square with protractor arms. Following is an example of average stretch problem:

Bolt measurement (hand tight)	0.675 in.
After "cold slug"	0.671 in.
Difference (cold stretch)	0.004 in.

From stretch chart:

Minimum	0.028 in.
Maximum	0.034 in.
Optimum	0.031 in.

Then: 0.031 = Optimum
0.004 = Cold stretch
0.027 = Stretch required
0.027 × 1.4 = 0.0378 or 0.038 in. (the distance the nut must be turned).

I don't know how other firms measure bolts, but here's what we do: Screw nuts on bolt hand tight, then measure bolt length with indicator and measuring rods. These measurements don't show actual bolt length, but serve as reference measurements only. Tighten bolts with a slugging wrench and hammer until you're sure case is faced off solidly. This usually stretches bolts between 0.003 and 0.004 in. Then measure bolt again. We call this the "cold slug" measurement.

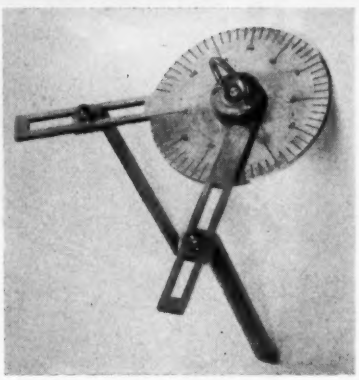
From chart furnished, find optimum stretch. Optimum stretch is difference between minimum and maximum stretch, added to minimum stretch. From this figure subtract the "cold slug" measurement. Multiply this last figure by 1.4 (we figure 40% stretch loss due to thread and metal variation). Answer is amount bolt must be stretched or elongated to have proper stress or loading when turbine is in operation.

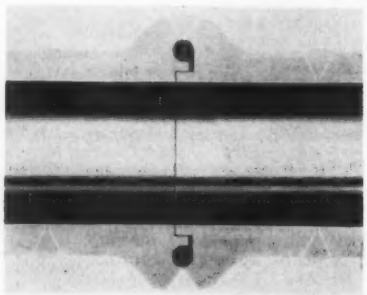
Rest of operation is simple. Place protractor on top of nut. Centering plug will fit in the eyebolt hole and keep the protractor centered. Adjust legs to OD of nut and lock them in place. Turn movable arm of protractor to amount of stretch desired and secure it with locknut. Mark position of legs.

We use chalk for marking. Keep chalk sharpened to make as thin a line as possible. Leg on protractor's fixed arm is used as a zero point, so reference mark must be made on turbine case at this line. After all nuts are marked, heat the bolts (use either electric heaters or a "rosebud" tip on a copper tube for the acetylene rig. Turn nut until the second line is in line with the reference mark on the turbine case. Allow bolt to cool before final measurement. Incidentally, while top nut is being turned, bottom nut must be held firm.

Tool gives more accurate layouts. It's faster than laying nuts out in flats.

H C Bosley, *Long Beach, Calif.*





Scale-free aluminum piping

Plant engineers can cash in on this new aluminum piping developed for aviation fuel lines. Scale-free welding coupling, left, eliminates risk of pumping products of corrosion and welding scale and icicles into fuel tanks. Coupling is of two forged halves with hub ends that fit pipe and fittings. When halves are joined, a cavity is formed just below the welding level. Complete penetration takes place in the final weld without danger of burn-through or formation of scales and icicles on the inside of piping.

Courtesy, Tube Turns, Louisville, Ky.

My biggest boner

Please turn to page 192

COLOR-PORT

water level gage

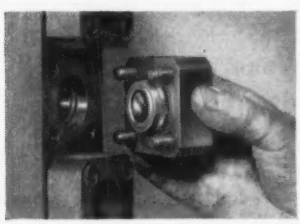
gives you . . . two-color readings
. . . low maintenance
. . . increased availability

You get a *triple advantage* with the Yarway COLOR-PORT boiler water level gage for pressures to 3000 psi.

Two-color readings are brilliant and clear. Water shows green; steam shows red. A full gage is all green and an empty gage all red.

Low maintenance with individual cover-glass assemblies, each held solidly in place by four socket head cap screws. "Floating assembly" design applies safe, predetermined loads on glass ports, reducing thermal shocks, permitting faster warm-up.

Increased availability means longer service life. Cover glass assemblies can be *serviced in place*, easily and quickly.



Yarway Bulletin WG-1814 describes the Color-Port Gage. Write for it.

YARNALL-WARING COMPANY
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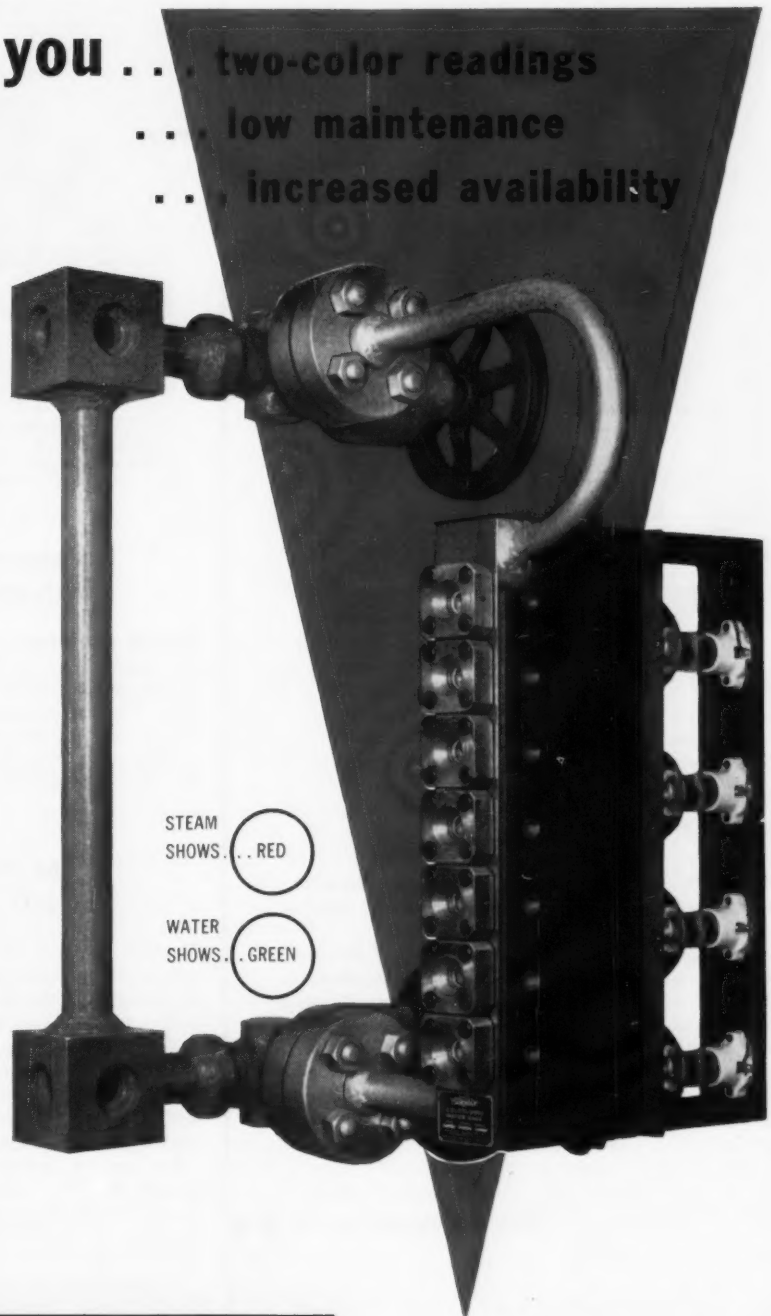
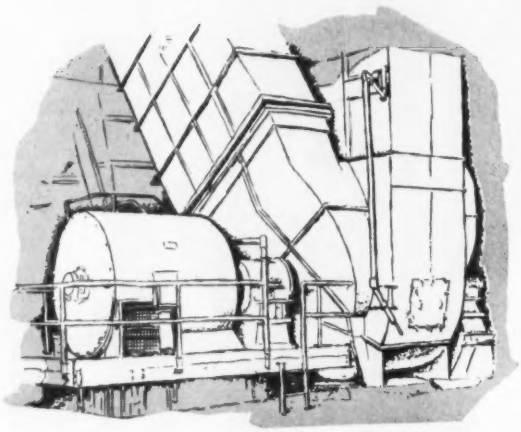


YARWAY COLOR-PORT . . . *a good way to specify high pressure water gages*

Have a PLANT PROBLEM? *Tap the*



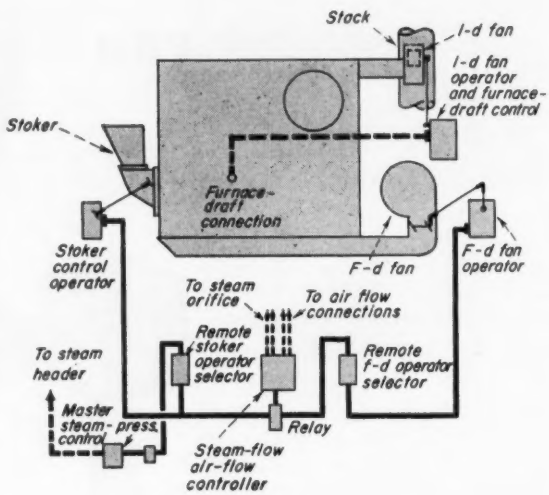
The problem

What's best way to control f-d, i-d fans?

We are installing a 50,000-lb-per-hr boiler operating at 450 psig, 650 F, to supply process and heating steam. The unit is spreader-stoker fired.

Forced-draft and induced-draft fans for this unit will be motor-driven. But we haven't decided on the best way to control them. We're considering vane, damper, hydraulic coupling, magnetic coupling and speed control. Have *Power* readers had experiences with these types? Which is preferred for a unit like ours? Load swings on this boiler will be considerable.—*HHV, April Power*

The solutions



I recommend damper control with pneumatic operators

I would recommend damper control with pneumatic operators for *HHV's* fans. If he applies it right, it will provide a simple, rugged control system which is accurate and trouble-free. Pneumatic operators should permit manual operation without disconnecting the linkage.

Diagram, above, illustrates the combustion control system I would use to operate the dampers.

W H KEITH, *Albany, Georgia*

For f-d: Vane control, for i-d: Hydraulic coupling

My first choice on the forced-draft fan would be vane control on the inlet side of the fan. A second possibility would be dampers on the fan discharge side. For 50,000-lb-per-hr boilers both of these methods have proven records.

With the vane setup, *HHV* will need a manually controlled damper in the discharge duct to allow operation during control failure or periodic maintenance such as cleaning out primary draft connections. With damper controls, it's a simple matter to go from manual to automatic operation.

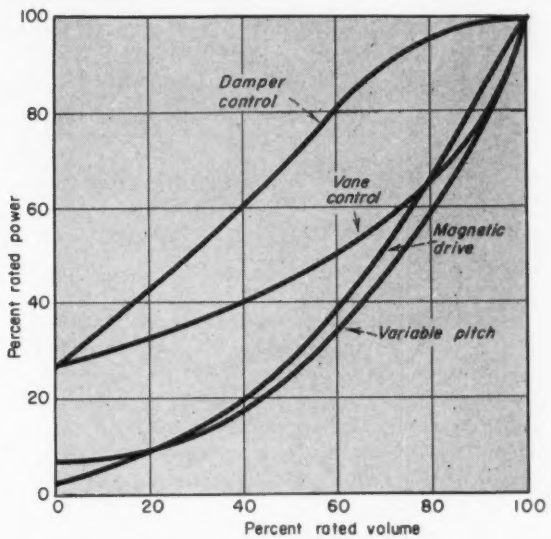
For the i-d installation, vanes are out of the question because of their exposure to the erosive action of flyash. Here I would use speed control in the form of a hydraulic coupling. It is available in a variety of sizes as a package, complete with auxiliaries.

Summing up, steaming rate would be regulated by varying i-d fan speed. Fuel speed would be controlled to maintain efficient combustion. And the f-d fan would maintain a slight negative pressure in the firebox.

B L BROWN, *Prospect, Ohio*

know-how of over 45,000 Power readers

HOWARD KALLEN, *Associate Editor*



Here are pros and cons of fan control systems

I would like to offer the following as food for thought.

Damper control is a tried and proven method, but it is a low-efficiency system. The damper uses the principle of destroying pressure—and pressure is power.

Vane control is an efficient system over a short range—100% down to about 85% load. Beyond this point, the vanes assume the function of a damper.

Hydraulic couplings offer a method of speed control which can give close control with fair efficiency.

Magnetic couplings offer a method of speed control over a wider range than hydraulic, with greater efficiency.

Vane-axial pitch control is a method not considered by *HHV*. The vane-axial fan usually requires less floor space than a conventional centrifugal fan. A fan rotor is mounted on the motor shaft, eliminating bearings, couplings or belts. The controllable pitch offers maximum efficiency and close control from 100% to 10% load, as shown on graph, above.

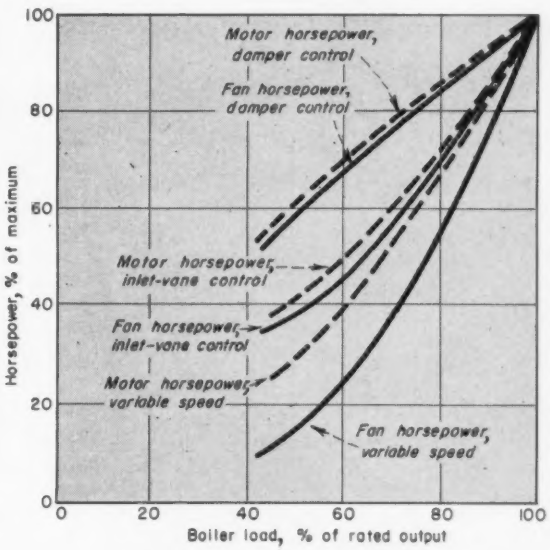
Using the vane-axial fan for i-d applications isn't always advisable unless flue gases are passed through a scrubber before entering the fan.

F L Moore, *Application Engineer*
Joy Mfg Co, New Philadelphia, Ohio

Use f-d, i-d dampers

I would control f-d and i-d fans with dampers. The fans should be run at constant speed and sized to match the boiler. Both sets of dampers open and close according to boiler demand. I-d fan holds a constant negative pressure, f-d fan a positive pressure as load varies.

C O Wagner, *Denver, Colo.*



HHV must figure loads, fixed and operating costs

Boiler fans, having variable-speed control, offer maximum operating economy. This type of regulation allows the units to operate at reduced speed at relatively high efficiencies compared to damper or vane control. Curves, above, show power requirements for different types of operation.

With spreader-stoker firing, solid particles in the flue gas can be a major cause of erosion of i-d fan blades and liners. Even where dust collectors are used, the erosion problem still exists. Where fans operate at reduced speed, life of bearings, shafts and wheels is increased. Noise can be reduced.

Maintenance costs for damper and vane controls are usually about the same. Hydraulic and magnetic coupling maintenance costs run somewhat higher. Where heat balance conditions are favorable, steam-turbine drives permit regulating fan speed directly and allow steam to be exhausted to process and heating services.

For *HHV's* boilers, turbine drives or hydraulic couplings would cost about 80% more than for constant-speed units with inlet vanes or dampers. Magnetic couplings would average about 60% more.

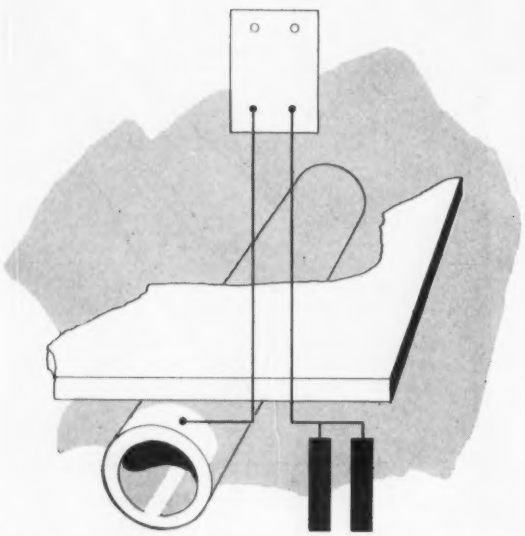
Knowing loads and energy costs, I recommend that *HHV* prepare estimates of fixed charges and operating costs for various control methods. From this study he'll be able to choose the arrangement with the lowest annual cost.

H B Wayne, *Woodhaven, N. Y.*

Want help with your plant problems? Send your design and operating headaches to us. We'll put Power readers to work on them.

Turn page for info on buried pipe corrosion ▶

More PLANT PROBLEMS Begins on page 128



The problem

Can soils rectify ac current, cause corrosion?

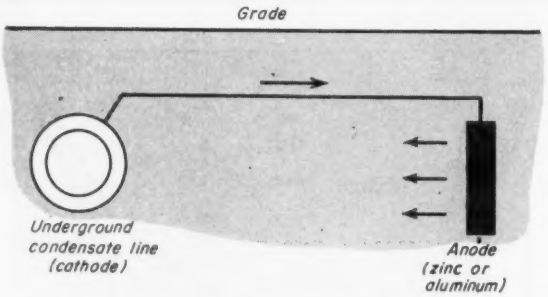
I ran into a particularly nasty corrosion problem recently in connection with a buried condensate line.

Condensate samples showed low carbonates and a reasonable pH. A well-recommended water treatment had been slug fed at regular intervals. The chemical feed, containing lignin and tannin, is supposed to have oxygen scavenging properties and the ability to inhibit all sorts of corrosion. But the condensate line was corroding.

An electrical engineer tipped us off to the possibility of stray ac getting into the system and causing corrosion by flowing through a film of metallic salts that act as a rectifier.

I once observed a failure of some piping buried close to the ac electrical service of a building. Failure occurred mainly in the vicinity of the electrical conduits but most people agree that ac can't cause corrosion. Could some soils be rectifiers? I would like some opinions from readers—*JSM, April Power*

The solutions



Is corrosion caused by galvanic action within system?

Corrosion may be caused by galvanic action within the system, not necessarily from external sources.

I would recommend applying cathodic protection to the condensate line, sketch, above. Zinc or aluminum would be anodic with respect to the pipe.

Be sure to make a good connection between condensate line and anode which is buried in the ground near the line.

G L BENGSTON, *Edmonton, Canada*

JSM's problem is internal corrosion

What you are really worried about, *JSM*, is that your condensate line is corroding. If the pipe is corroding on the outside alone, and in an area where stray ac current is transforming sufficient potential to form galvanic corrosion on the pipe's surface, you need some cathodic protection for this line—probably for the entire line. This will require soil-resistivity readings, cathodic-current requirements, grounding continuity, etc.

If, as I suspect, internal pipe corrosion is the culprit, check the condensate. Condensate pH should be between 8.5 and 9.0. If condensate is of lower pH, add chemicals.

Morpholine is an amine that will increase pH and guard against corrosive action of CO_2. You may possibly have CO_2 from breakdown of carbonates. Amines can be filming or volatile, depending on your pressure and need.

Hydrazine can be added in minute amounts, in conjunction with morpholine. Amount should be about 0.05 ppm above the existing dissolved O_2 residuals.

Sulfite can be used as a substitute for hydrazine.

Total dissolved solids of condensate should not be more than 1.0 ppm for ideal conditions. If it's above this figure, you may need to improve boiler-water or feedwater treatment. Items to be checked for the boiler water are: (1) deaerators (2) steam separators in the boiler drum (3) chemical treatment. For boiler-makeup water, consider demineralization, evaporators and zeolite softening.

J E BURGUET, *Jackson, Miss.*

For more on pipe corrosion and new problems, turn page ▶

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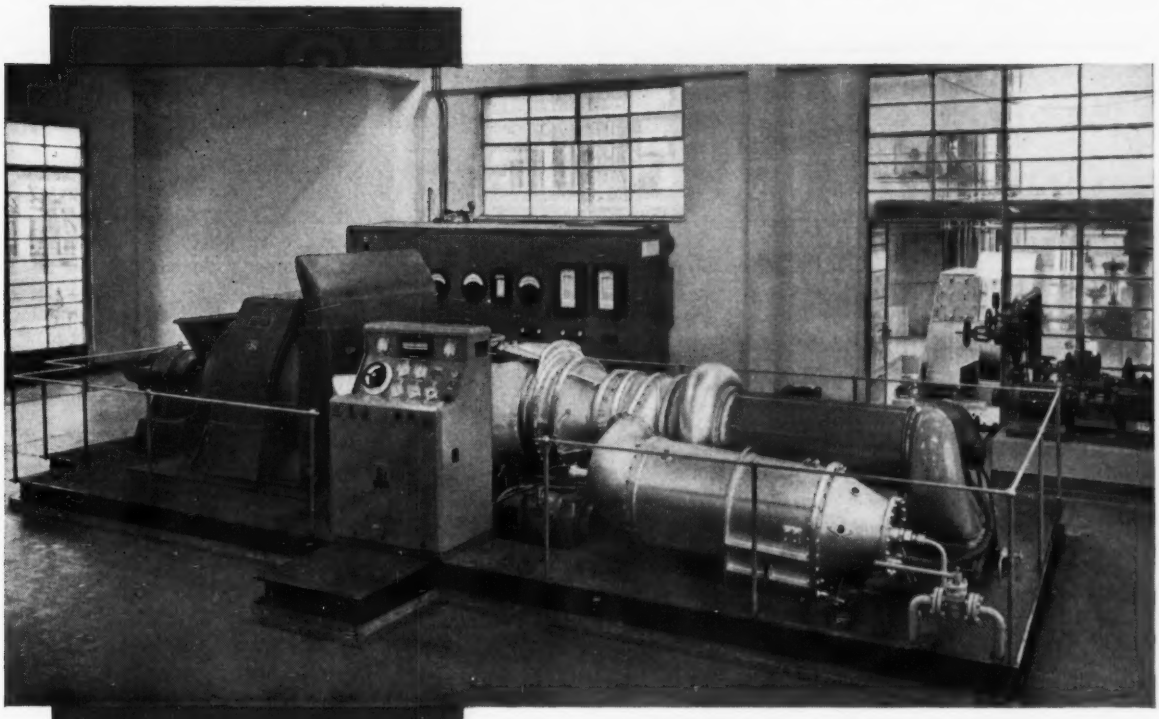

The Mark TA gas turbine generating power and process steam in a refining application.

all power services in one package

In applications where multiple power services are required such as power generation, compressing, pumping, space heating, refrigeration, air conditioning, drying, or evaporating, the Clark Mark TA gas turbine is the economical choice.

Exhaust gases from this 1,150 bhp. gas turbine contain up to 10,000,000 BTU/H of recoverable energy at a temperature of 870°F. While these gases contain some products of combustion, 90% of the original oxygen content is still present.

The exhaust gases are useful where preheated air is desirable for combustion or supercharging purposes, for drying applications, catalyst regeneration, feedwater heating, evaporation of sea water, etc. These gases can also be used in air to air heat exchangers for space heating or to generate up to 9,500 pounds of low pressure steam per hour for process use. If even higher temperature gases are required, the Mark TA can be used solely as a power gas generator to provide gases of 1020°F at 20-22 psia. and a mass flow of 20 pounds per second.

For large stores, auditoriums, hotels, hospitals and office buildings, the Mark TA can provide approximately 1800 tons of air conditioning or refrigeration in the summer using the absorption cycle and also provide steam for heating in the winter. In all applications except power gas generating, this modern gas turbine also supplies 1,150 bhp. of rotative energy for pump, generator, or compressor drive.

Clark engineers stand ready to assist you in applying the Mark TA gas turbine to your application. Larger units with ratings of 9,500 bhp. are also available from Clark. Write for Bulletin No. 142.

CLARK BROS. CO., OLEAN, N.Y.
One of the Dresser Industries
Offices in Principal Cities Throughout the World

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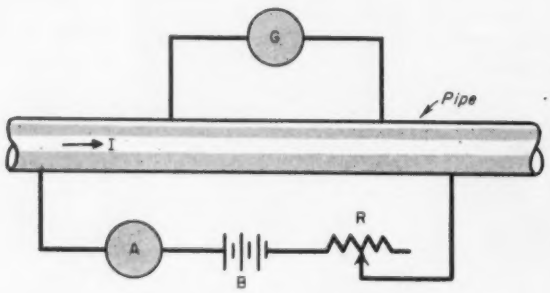
Clark Bros. Co. is licensed to manufacture the Mark TA gas turbine in this country by Ruston-Hornsby, Ltd., Lincoln, England.

More PLANT PROBLEMS Begins on page 128



Is corrosion internal or external?

If corrosion is internal, present water-treating procedures may not be adequate. Condensate should be tested by an experienced water chemist. Results of the test will help *JSM* to select the treatment best suited to his conditions.

If external corrosion is the problem, he can run the test shown in sketch, above. Here's how: Adjust resistance *R* until galvanometer *G* reads zero. Then current from battery *B* is equal and opposite to current *I* in the pipe. The ammeter reading *A* indicates current flow resulting from electrolytic action.

Also, he can coat the pipe with asphaltic coatings, lacquer, zinc paints, metallic plating or galvanizing.

H B WAYNE, *Woodhaven, N. Y.*

Moist ground may be culprit

JSM's trouble may come from either of these two causes:

(1) There may be negative direct current taking a short-cut across country through some moist ground. In spite of its low voltage, dc negative will travel long distances and by devious routes, even where there is a good negative return.

On one occasion, I opened a union on a 1-in. water pipe that ran from a 6-ft diameter main across some marshy ground that was sometimes under water. The water main ran under a street car track a half-mile away. When I broke the union there was a very noticeable spark.

(2) Where pipes run through moist ground, a combination of different metals in the piping system and certain metals in the ground, may set up a powerful galvanic action that may attack a spot in the pipe and eat through it in a short time. Remainder of the pipe may go undamaged for years.

H T LIVINGSTON, *Los Angeles, Calif.*

Stray ac may cause corrosion

It's a well-known fact that stray ac may cause pipe corrosion. Although, theoretically, this should not be the case.

Oxide films deposited on pipe surfaces act as rectifiers. True, they're poor rectifiers, but they're sufficient to modify the stray ac, give it a dc component that can cause corrosion. Because only the dc is active in causing corrosion, stray ac is always less dangerous than stray dc of the same intensity.

A R STUDI, *La Tour de Peilz, Switzerland*

Some soils are natural rectifiers

Not only are some soils natural rectifiers, but if your pipe is buried beneath a lush lawn, it will corrode more rapidly because a common ingredient of fertilizer is ammonium phosphate. A forerunner of the present half-wave chemical rectifier was one that used ammonium phosphate in water and aluminum-steel electrodes.

JSM may even find buried aluminum or other less noble metal near by. Also, if the pipe was galvanized, it may have been eaten away by electrolysis and the base metal is now being attacked. If electrolysis is the trouble, cathodic protection can solve the problem.

W E BRUMBY, *Levittown, Pa.*

Your July problems

How can we keep anion exchange resins from deteriorating?

We have a two-bed demineralizing system in our power plant that passes 100 gpm continuously. Effluent is normally expected to contain about 3-ppm total dissolved solids. We use a surface-water supply that goes through a coagulator and filter before entering the demineralizer.

The plant was originally designed for daily regeneration. It's now necessary to regenerate the anion unit twice a day. Unless we can stop this capacity dropoff, we'll have to replace the anion resins. The incoming water has been regularly analyzed and there has been no significant change. Have *Power* readers had similar experiences? What can we do to lick this knotty problem?—*MR*

Why do stack temperatures get so high?

We have two 80-hp boilers. They are packaged type, automatically gas fired. Pressure control allows either 95- or 45-psi generation.

With both boilers operating together, or each one operating separately, combustion efficiency is 82½% (by CO_2 indicator). Stack temperature of one ranges between 450 and 700 F, depending on firing conditions. Temperature for second unit at the same point, and under seemingly identical conditions, ranges between 600 and 900 F. Can *Power* readers tell me how to correct this condition?—*CAR*

Sit down right now and answer one or both problems.
We'll pay extra for answers with photos, sketches.

Complete control
of temperatures with
PABCO
PRECISION-MOLDED
CALTEMP
a Calcium Silicate
Insulation

Name your temperature. A performance-proved Pabco pipe or block insulation will maintain it at economical levels up to 1900° F. With Pabco Caltemp, 85% Magnesia, or Prasco Insulations, heat losses are reduced to an absolute minimum . . . finest performance assured. For data on technical advantages, case histories, or engineering consultation . . . write . . . or contact one of Pabco's insulation engineers.

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ARGUMENTS . . . *let other readers know your views*

ALTHEA THORNTON, *Assistant Editor*

Says program solves lube problems

Frankly, I am tired of all the fuss about lubrication. Every technical magazine has articles on how to grease a bearing, or the dangers of using the wrong lubricant.

Two or three times a month, some salesman comes around with lube equipment that he claims will eliminate all my troubles. Some of this may be good, but, taken alone, it is not the answer.

I am not a lubrication engineer nor do I think a man need be in order to have successful plant lubrication. Here's my four-point program:

1. Get the right lubricants. Most of the major oil companies have men who are highly trained in proper lube application. Their services are usually free.

We had an oil-company engineer spend a week in our plant. Together, we listed every piece of equipment—its bearings, gears, etc. As we went along, we made notes of the type and condition of each, and he recommended lubricants. Since then, we have not had a single failure that pointed to use of the wrong lubricant in any equipment.

2. Feed the proper amount into the bearing. Most engineers agree that overlubrication is as harmful as underlubrication. A properly trained oiler eliminates trouble here, if bearings are fitted right.

I say that every bearing should be operating, and the relief plug removed, while it is being greased. If the fittings are not accessible, use copper tubing to make them accessible.

We pipe all our grease and relief fittings out to a safe location so all motors and equipment can be lubricated while operating. On gear boxes, we pipe out the fill, drain and oil-level plugs.

Be sure to maintain the proper oil level in gear boxes. And if your bearings have no relief plugs, ask the manufacturer about installing them. If this is not possible, your oiler will need good judgment.

3. Lubricate at the proper time. Under severe conditions, bearings may need lubrication every 60 days; under less severe service, once a year may be sufficient. Tag each machine, showing bearings and gears to be lubricated, the proper time interval, and right type of lubricant. Use back of tag for a check list to be marked as work is done.

4. Hire a good oiler. This man is worth his weight in gold. He can cost or save you a lot of money. If he feels that his job is unimportant, show him that he's wrong. See that he is fully informed. Get lubrication and bearing data into his hands, and find time to discuss it with him. Remember, he means the success or failure of your program.

C A GILL, *Richmond, Va.*

EDITOR'S NOTE: This is Gill's program. He's happy with it. Would it suit *your* needs? Send in your views, and watch for comments in a future issue.

Reducing stations need safety valves

In POWER, January, p 95, are two sketches showing the right and wrong way of assembling pressure-reducing stations. I say they are both wrong.

In center column, top of p 95, the author states, "Where layout makes it impractical to put a safety valve in the delivery piping . . ."

Why is this impractical? Safety valves are made to be installed anywhere, any place, at any angle. I say safety valves *are* practical. Process equipment has exploded more than once because: (1) There was no safety valve protection on the low-pressure side. (2) Safety valves were either defective, of the old ball and lever type or too small.

One of the greatest jokes at a reducing station is the sight of a large-sized steam main from the boiler to a misfit reducing station, and on the low-pressure side, a ¾ in. safety valve on large diameter pipe.

The low-pressure piping should have one or two safety valves the same diameter as the delivery line or several valves with a discharge area equal to at least 1½ times the area of the low-pressure line.

J M GORRIE, *Euclid Ohio*

Best way to avoid stoker troubles?

When a stoker is on the line, a good operator will not remove the forced air without permitting some natural draft flow. Removing forced air subjects stoker to the intense radiant heat of the fuel bed and furnace walls. Temperatures increase rapidly and air spaces between the links are reduced, causing more troubles. Adjust the automatic combustion control so forced air is not completely shut off, even at minimum rating.

Fuel bed must be deep enough to withstand the full forced pressure at high rating. Otherwise, the bed will be disturbed, causing other troubles—even arch erosion in extreme conditions. Regulate fuel bed so fire burns out straight. This requires correct depth and coal size, plus uniform spreading.

The right depth leaves more ash to protect stoker from radiant heat. It also allows more time for flame to burn before reaching the comparatively cool heating surface, and gives the stoker more time to cool.

JAMES REED, *Matteson, Ill.*

One of a series.

Some Things to Think About Steam Traps

...in order to get high operating efficiency and a minimum of maintenance

The gentleman who invented the wheel had a basic idea and so far no one has come up with anything better for the purpose.

If you'll pardon us for a little overemphasis on the significance of steam traps, we'd like to liken one of them to the wheel.

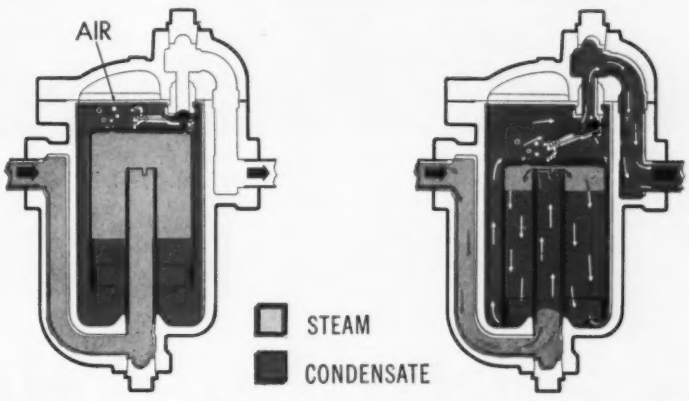
In 1911, when the first Armstrong inverted bucket steam trap model was announced to the world, or at least that part of the world that modest advertising and sales budgets would cover, it was not received with equal enthusiasm by all (especially old-style trap makers). But, like the wheel, it managed to find its way into general use. And, nothing better has ever turned up for the purpose of draining condensate. As a matter of fact, the Armstrong trap has been very widely copied. Today, there are more inverted bucket traps draining process equipment than any other kind. Of these, there are more Armstrongs.

If this sounds like the boasting of a proud parent, give consideration to some fundamental requirements not met by all traps:

1. ***A steam trap should not leak steam.*** Some traps do, you know, because of the nature of their operating principle. No steam ever gets to the Armstrong trap orifice. The valve is always water sealed.

2. ***A steam trap should vent "air" as fast as it accumulates***—otherwise temperatures are reduced and corrosion is a problem. The Armstrong trap handles air very nicely. The vent in the bucket permits air to accumulate in the top of the trap, from where it is discharged when the trap opens. For extreme conditions like draining paper machine dryers, some jacketed kettles and certain other units, the vent is sized larger for the job. And, for handling big volumes of air during warm-up, a bucket with an auxiliary thermic vent really speeds up heating.

3. ***A steam trap should discharge condensate at steam temperature*** if you want to get maximum efficiency from the unit drained. And most people certainly do. If you have to wait for the condensate to cool, it's almost impossible to maintain maximum temperatures and prevent air build-up. You guessed it—the Armstrong trap opens for water, without dependence on temperature.



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

4. ***A steam trap should be suitable for any return system.*** The Armstrong trap works just the same whether discharging to atmosphere, back pressure or vacuum. It has been conclusively proved that flash steam resulting from use of a bucket trap does not cause a problem in vacuum return systems. The flash condenses rapidly. It's the leaky traps that cause the headaches.

5. ***A steam trap should not be a "prima donna".*** Some kinds of traps take an awful lot of care and coddling. The Armstrong trap is a rough and ready type with a hardened chrome steel constitution (valve and seat, to be exact). It cleans itself of ordinary dirt and scale without choking up. Its 18-8 stainless parts stave off rust and corrosion. It resists wire-drawing and wear remarkably well. In fact, it stays on the job longer with less attention than any trap ever produced. Unless you live in Siberia, you can probably find a user around the corner who will tell you so from experience.

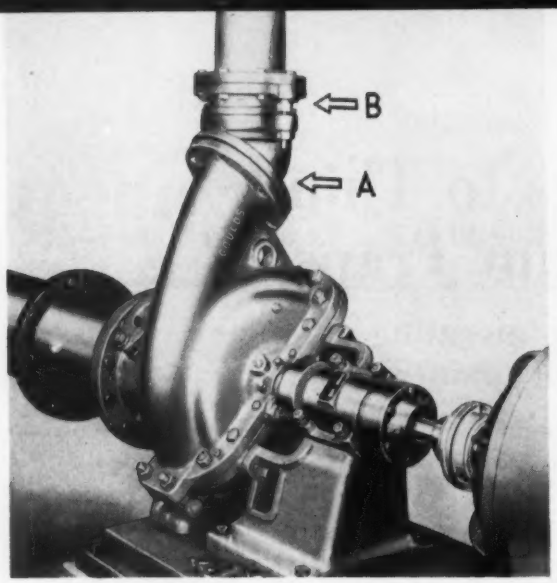
6. ***A trap should not be an "orphan".*** With Armstrong traps you can *always* get prompt service and parts from nearby Factory Representatives and stocking distributors as well as from the factory.

7. ***A trap should have a guarantee.*** The Armstrong trap is unconditionally guaranteed to give you *complete satisfaction* (as to doing its job, that is). If it doesn't, you can get your money back.

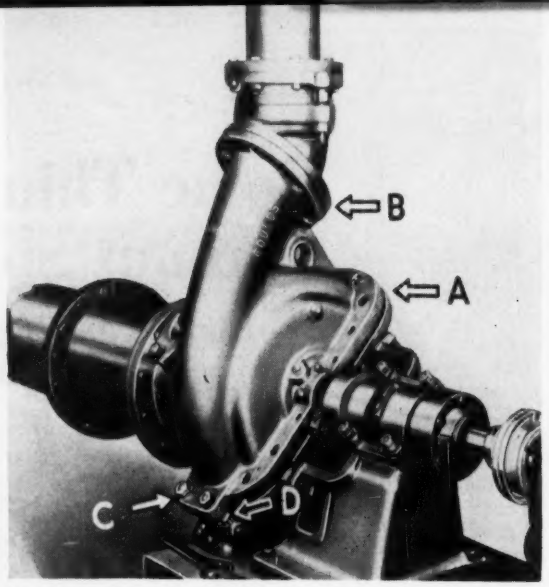
If you'd like to buy some of these excellent steam traps, call your local Armstrong Representative or write **Armstrong Machine Works, 8127 Maple St., Three Rivers, Michigan.**

ASK FOR the 44-page Steam Trap Book, free on request without obligation.

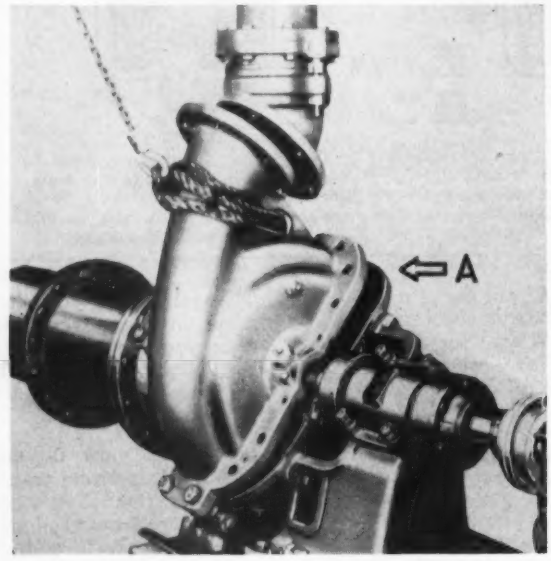
ARMSTRONG STEAM TRAPS



1 First, remove bolts connecting discharge elbow and upper half of pump casing, marked *A* in photo. To provide clearance and preserve gasket, telescope the discharge elbow into connection *B* by loosening upper nuts, tightning lower nuts



2 Next, remove parting bolts connecting upper and lower half of casing. Raise upper half of casing by loosening the top nuts *C*. Raise casing off the side-plate locks by tightening hex nuts *D* below upper half flange. Jack opens with screw *A*



3 Now, attach chain fall as shown and continue to raise casing with jack screws *A*. Smaller pumps of this design need no chain fall as upper half of casing can be hinged back by inserting a rod through cored hole in upper half of casing

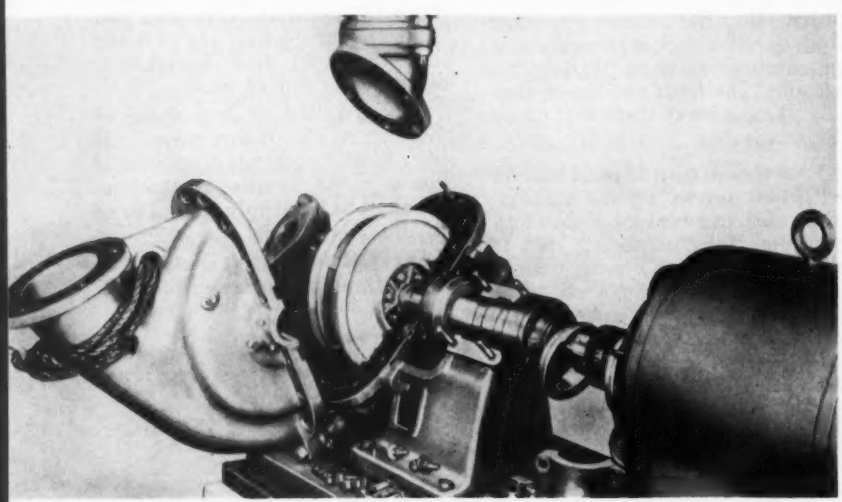
HOW TO

Reduce pump downtime

► DOWNTIME is the modern plant engineer's nightmare. Repairing or overhauling pumps can skyrocket costs and stop process flow. But how do you cut down on this expense?

Pump, shown, handles paper stock, pulp, mashes and other thick liquids. Such pumps are opened frequently because they clog. So this pump is designed with a hinged cover that has jacking bolts. Design saves both time and manpower when removing the upper half of pump casing to check or remove rotating element. Follow sequence shown here to open, then reverse the procedure when closing.

Design engineers might give some thought to this feature for other types of machinery that needs frequent opening.—*Courtesy, Goulds Pumps, Inc, Seneca Falls, New York*



4 Pump is completely open. You can now remove bearing cap. Disconnect coupling and rotating element. Then lift assembly from casing. When you are ready to close pump, follow these steps in reverse. You'll save costly maintenance

Klingerit gaskets keep joints tighter longer

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BASICS . . . *bringing engineering theory down to earth*

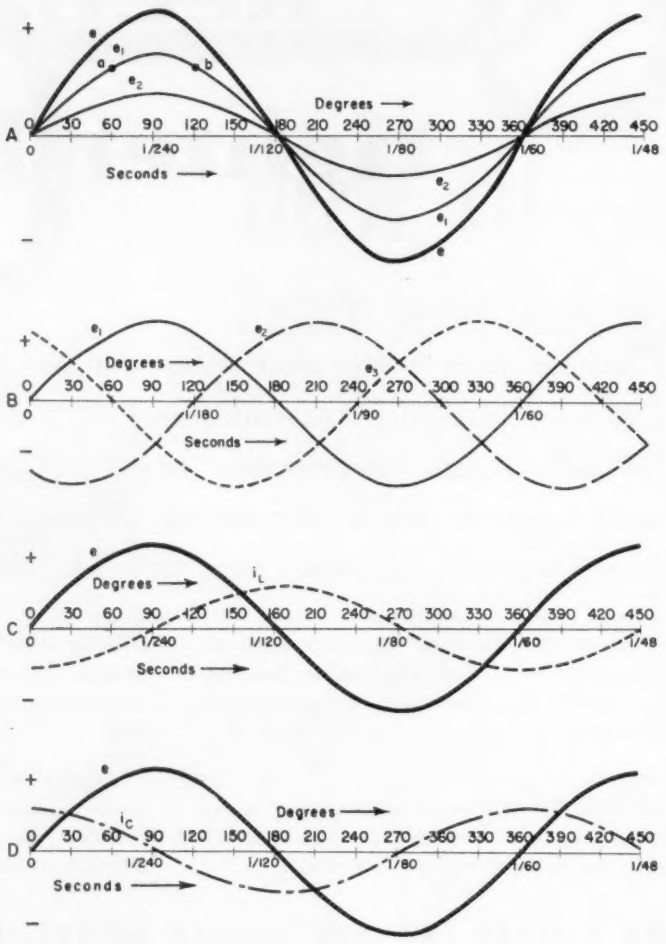
NORMAN PEACH, *Assistant Editor*

Electricity: 12

What *phase* means in ac circuits

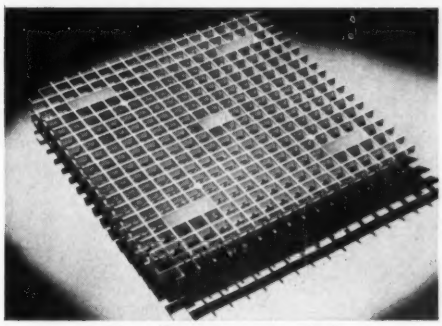
► WE USE THE WORD phase for a few different things when we're talking about alternating current. We saw in May's *Basics* how an electromotive force (emf) generated in an ac generator can be represented by a wave that repeats itself. Strictly speaking, a phase is any point on such a curve corresponding to a certain number of degrees of rotation. Points *a* and *b* on curve e_1 are at different phases of the curve, sketch *A*, right. Degrees of rotation correspond to an actual amount of time. On a 60-cycle curve, one cycle or 360 deg equal 1/60 sec, 180 deg equal 1/120 sec, etc. Difference in phase represents difference in time. Two curves are *in phase* if corresponding points on each curve occur at the same time, as on curves e_1 and e_2 in sketch *A*. Note that these voltages are at a positive maximum at the same time (90 deg or 1/240 sec), both zero at 180 deg or 1/120 sec, both a negative maximum at 270 deg or 1/80 sec, etc. Suppose that e_1 and e_2 represent the voltages of two generators in series. Then at any instant the total voltage would be the sum of the two voltage waves, shown by the resultant curve *e*.

Now if a generator were connected in such a manner that it produced three emf waves corresponding points on which were 120 deg apart, a *three-phase* system of voltages would be generated. Considering the 3-phase 60-cycle emf curves in sketch *B*, e_2 begins to increase in a positive direction 120 deg or 1/180 sec later than e_1, and e_3 begins 120 deg later than e_2 (or 1/90 sec later than e_1). This is our familiar 3-phase system. The resultant of the three emfs is always zero, that is, the sum of the emfs in the positive direction is equal to the sum of the emfs in the negative direction. This makes it possible to transmit 3-phase current in a 3-wire system. If the three wires are labeled *a*, *b* and *c*, e_1 appears as a voltage between *a* and *b*, e_2 between *b* and *c*, and e_3 between *c* and *a*. Each of these voltages (e_1, e_2, e_3) constitutes a *single-phase* voltage, as would *e* in sketch *A*. Single-phase voltage obtained from a 3-phase sys- (*Continued on page* 190)

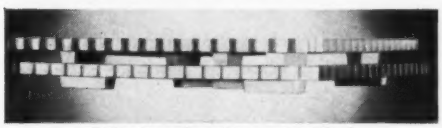


announcing

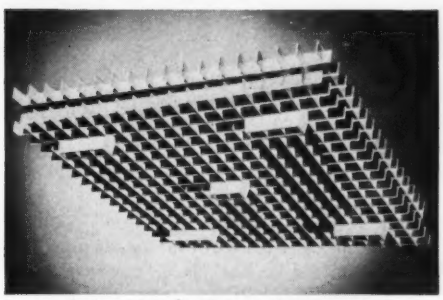
FLUOR'S NEW poly-GRID



Overall top view as installed



Side view of packing as installed



Bottom view showing spacing supports

Contact your nearest Fluor Representative for details.

POLY-GRID can be easily installed in any counterflow induced draft cooling tower—regardless of make or model!

Call him today!

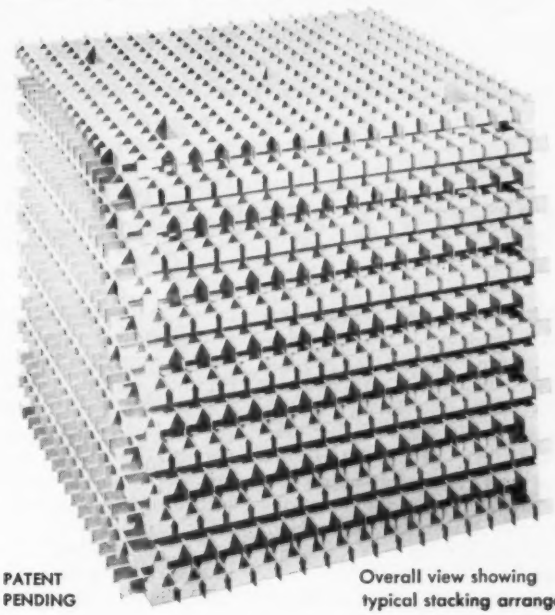
MORE COOLING IN YOUR EXISTING TOWER

To increase the throughput of your existing counterflow induced draft cooling tower, Fluor Products Company now offers "Poly-Grid" packing.

This revolutionary packing provides greater cooling surface — greater overall heat transfer; yet construction is open, and pressure drop low.

"Poly-Grid" is available in high impact polystyrene or linear polyethylene to meet all water conditions.

Fluor "Poly-Grid" packing allows you to cool more water under existing operating conditions, or to realize extra cooling of present throughput — all at minimum capital expenditure.



PATENT PENDING

Overall view showing typical stacking arrangement

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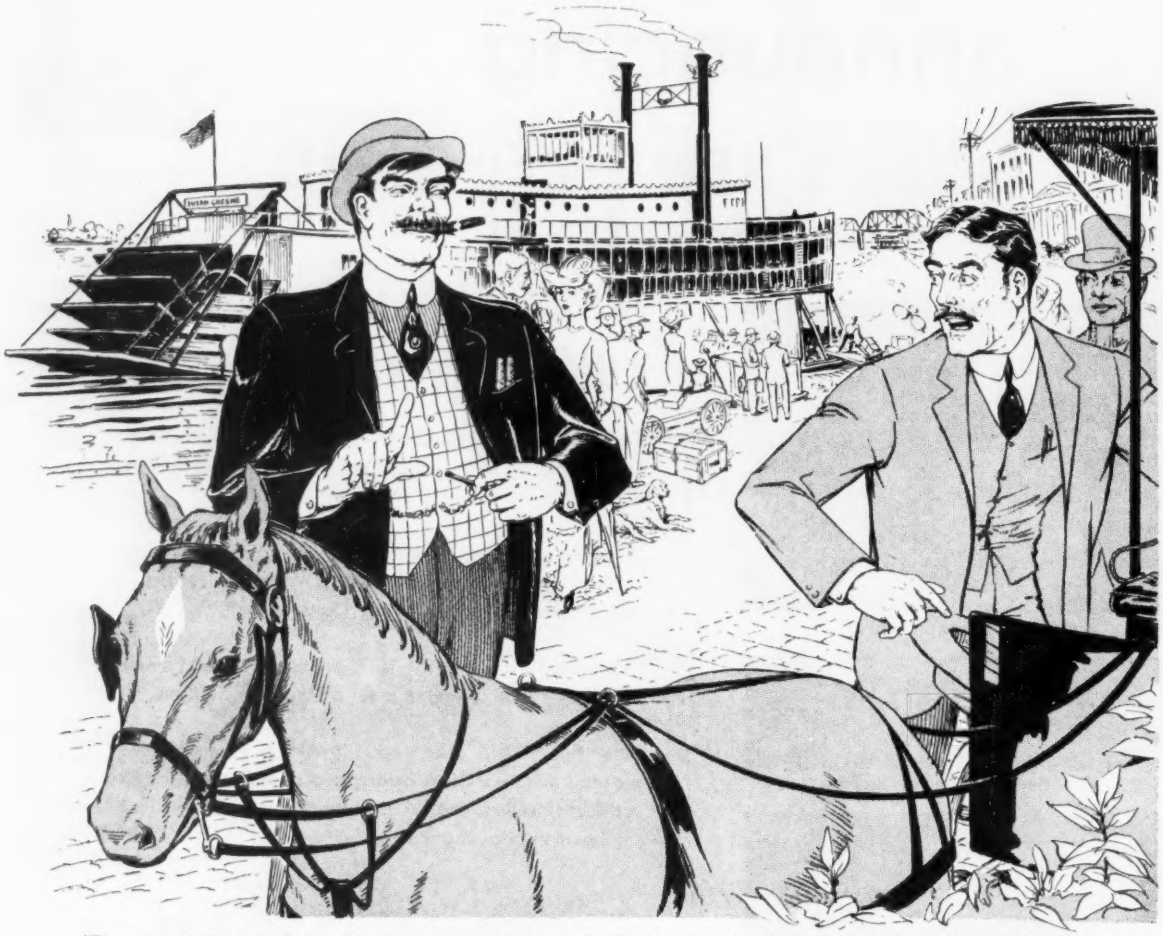

"There was the food merchant in his carriage, near the gangplank. Said he wanted to drive me out to his plant," roared Marmy

Marmy's gas-pipe cure

► MAINTENANCE is such a costly item today that some of our largest industrial firms turn over all their maintenance to consultants. I ran into one case where an outside firm of specialists cut costs by $200,000 the first year. How? They surveyed the plant; had a lot of machinery that had been bleeding the manufacturer white thrown on the junk pile. Then they installed modern equipment that will amortize the investment within several years.

"Wonder what the old consultant Marmaduke Surfaceblow has to say about such goings on," I asked myself. "Think I'll go down to the Bent Propeller Bar and find out."

The Bent Propeller, along our New York water front, had standing room only when I arrived. Reason? No less than a dozen slick ocean liners were berthed along the busy neighboring docks. Thirsty mariners crowded the tables and were standing three deep at the long bar. Smoke, noisy chatter, loud lusty laughter and clanking glasses made it a bedlam.

Once inside, I edged toward the tall figure leaning on one end of the crowded bar. His battered gray bowler was down at the bow as he gazed at his favorite beverage before him—a bottle of Sandpaper Gin.

"Mr Surfaceblow," I started, trying to raise my voice above that babble of noise, "What's your idea of maintenance consultants taking over repair work in some of our largest plants today?"

Marmy suddenly came to life, grabbed his bottle, worked up an 18-inch vacuum on his ballast pump and drained the bottle dry. Then he slammed it down on the bar and roared in his foghorn voice, "BILGEWATER on maintenance work. I'll tell you about the time I cured three sick boilers and all I used was a piece of beat-up gas pipe."

That did it. The place became quiet as a church. Glasses were put down and weather-beaten mariners turned their eyes respectfully toward our hero. The sage of the water front turned his back to the bar, hooked his thumbs into the armpits of his checkered vest, gave his bowler a starboard list, then blasted away.

"Back in 1912, I was chief engineer of the Mississippi River packet boat *Susan Greene*, running between Vicksburg and St. Louis. She was a steel-hull boat of 157 ft, 36-ft beam and drew 5 ft of water when fully loaded. *Susan* was a frisky stern-wheel hussy.

"Western style return-flue coal-burning boilers supplied steam to her engines at 180 psi. Cylinders at her twin engines were 16 in. diameter with 6½ ft stroke. At 22 rpm, the old girl cranked out a hefty 800 hp.

"The owner of a food-processing plant near Cairo, Illinois was a passenger on my last trip. He sat at my table in the dining salon, so we got well acquainted.

(*Continued on page* 180)

The Power Plant Engineer Said: "I WOULDN'T KNOW..."

INQUIRING REPORTER: So you use Nalco System water treatment ... How often are your boilers turbined?

ENGINEER: I wouldn't know—only worked here seven years. *

You recognize the Engineer's answer as a twist on the old one about *How-often-do-you-get-a-raise-around-here.* Our excuse for bringing it up is that the engineer's answer applies to hundreds of plants using Nalco water treatment. New plants, starting boilers from scratch with Nalco, report years on line, *billions* of pounds of steam generated in boilers that have *never* been turbined ... and probably never will be. Older plants, where turbining was as routine as checking the draft gauges, now open boilers only to show the inspectors.

These Nalco *results* can quite possibly be duplicated in your plant, regardless of the kind or severity of your water treatment problems ... or the size of your operation. Write or phone, now, for a fast start toward permanent water treatment security.

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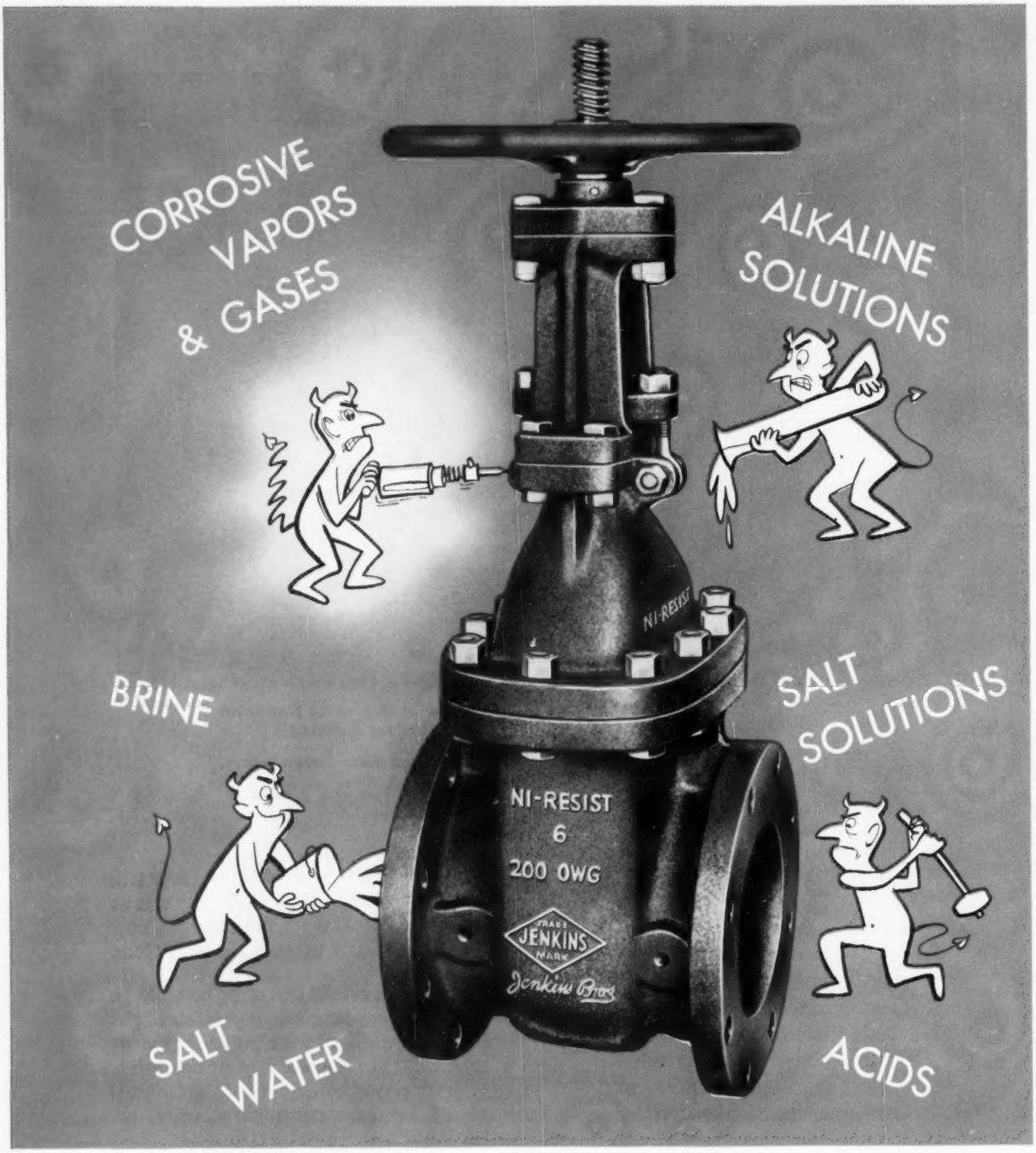

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of corrosive and erosive services

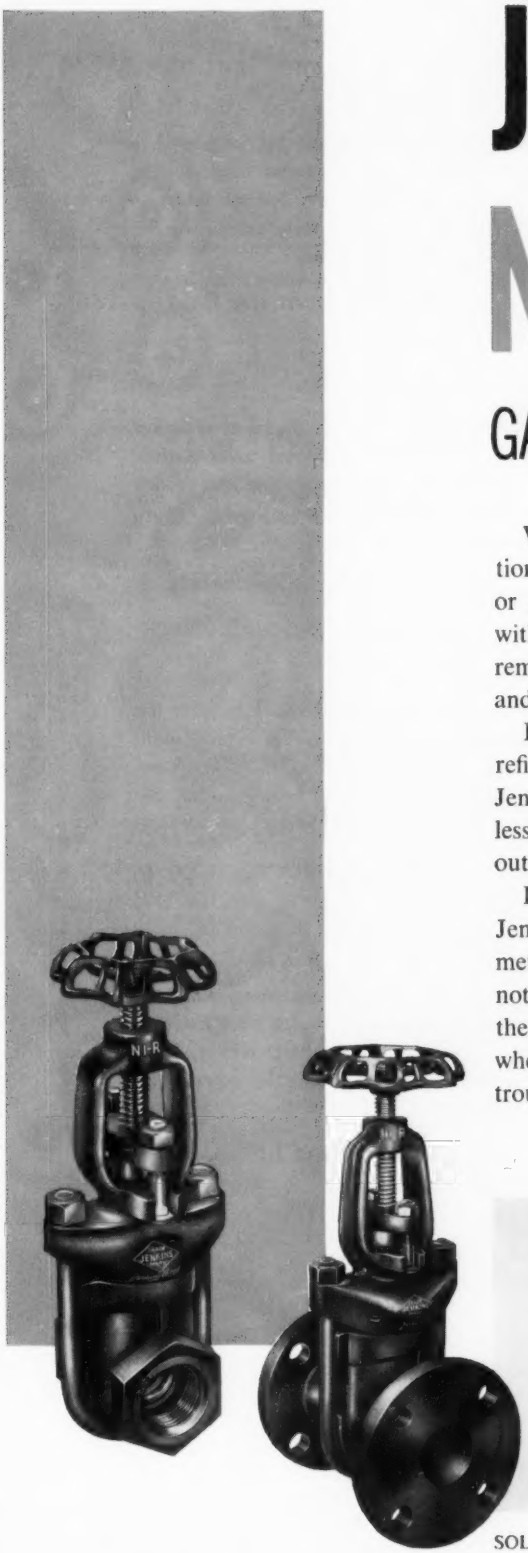
JENKINS NI-RESIST

GATE VALVES

Where you encounter acids, salt and alkaline solutions, sea water, brine or other corrosive fluids, vapors or gases, you'll want Jenkins Ni-Resist Gate Valves with type 316 stainless steel trim. They have a remarkable ability to withstand destructive corrosion and erosion.

In paper mill service, food processing, petroleum refining, chemical plants and other process industries, Jenkins combination of Ni-Resist and type 316 stainless steel, plus Jenkins extra *value* construction throughout greatly extends valve life.

Designed especially for corrosive services, the Jenkins Ni-Resist line of gate valves also has superior metal-to-metal wearing qualities. Copper-free, they will not discolor or contaminate products being carried in the line. Let the famous Jenkins Diamond be your guide when choosing Ni-Resist valves . . . it means longer, trouble-free service.



JENKINS VALVES

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SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

Reader service section

Start with these quick samples...

Sugar and spice . . .

and everything nice—that's what little girls are made of. But are they made of the stuff it takes to be good engineers? Some firms, feeling the manpower pinch, are beginning to hope they are. For the latest on this, read *Ladies in the limelight*. And don't miss the story on the wonder material that may erase some design engineering woes.

Reports from the field, p 146

Atomic wastes . . .

pose a serious disposal problem. Nine papers in our digest of technical essays deal with this important subject. Remaining papers cover nuclear plants, corrosion and hydro. A few minutes spent appraising this section will save you hours of digging. If you decide on reading the full report, we supply info on where to get it.

Technical briefs, p 148

Dog days . . .

are just around the corner. So if you're looking for ways to beat the heat, you'll find a full page devoted to air conditioning in our plant equipment section. Three remaining pages are devoted to valves, electrical equipment and an air preheater. And if you like, you can get further details on a product by using our Reader Service post cards.

Plant equipment news, p 152

Closely allied . . .

with our feature on plant equipment is this section devoted to manufacturers' bulletins. All bulletins are free. They range in size from the one page spec sheet to the 100-page catalog, and in subject matter, from air conditioning to nuclear energy. If you're in the market for equipment, you should certainly check this section too.

Free literature, p 161

The price of dreams . . .

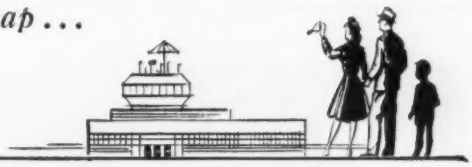
is never cheap. Their fulfillment is bought with hard work and that extra something that makes men great. The French call it "je ne sais quoi;" George Edwards calls it "impact"—a combination of speed and weight. Seems to him that the guy with the meatiest ideas and a gift for communicating them quickly just has to go to the top. See if you agree.

George Edwards, p 164

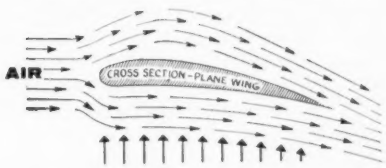
For other timely ideas, see following service pages ▶

HOW THIS MODERN STEAM TRAP UTILIZES PRINCIPLE OF AIRPLANE LIFT!

New application of an old principle produces totally different type of steam trap . . . of great simplicity and effectiveness



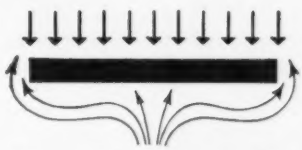
THIS GIVES AN AIRPLANE LIFT



Greater speed of air over curved upper wing surface creates lower pressure over this area (Bernoulli's Law) . . . resulting in **lifting** force.

THIS SAME PRINCIPLE USED TO CLOSE SARCO TD STEAM TRAP VALVE

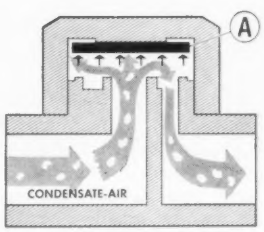
Valve is a simple hardened stainless steel disc.



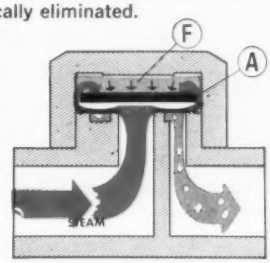
High velocity steam jet across bottom of valve disc creates low pressure area — resulting in **downward** force.

ONLY SARCO TD USES THIS UNIQUE OPERATING PRINCIPLE

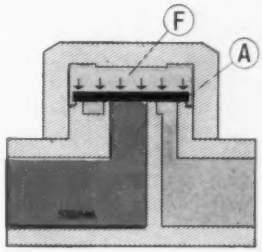
Result: Extreme simplicity—no valve mechanism—maintenance practically eliminated.



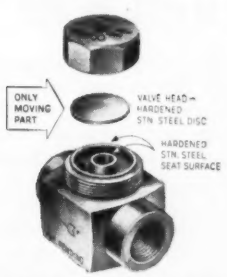
1. Inlet pressure raises disc "A" from seat . . . immediate discharge of air and condensate at steam temperature.



2. Steam follows condensate and the high velocity jet across bottom of disc "A" creates low pressure area (Bernoulli effect) . . . jet is deflected into chamber "F" where it builds up pressure by re-compression and this pressure acts on top of disc "A" . . .



3. Pressure in chamber "F", acting on full top area of disc "A", exceeds force of incoming steam and low pressure area under disc . . . and immediately forces it down, closing inlet. As condensation decreases pressure in chamber "F", disc rises and steps 1 or 2 repeat.



Small size . . . large capacity

Only 3 parts . . . all stainless steel. Sizes ⅜ to 1"—each body is as small as a tee fitting! Capacity is determined not by a bulky body but by the effective orifice, valve action, pressure drop and condensate temperature.

A few of many advantages

* *Practically no maintenance*—no valve mechanism, no narrow channels. Trouble-free, simple design.

* *Cuts trap inventory*—one large capacity seat for all pressures . . . for heavy, light, or no condensate load.

* *Self-adjusting for pressures 10 to 600 psi*—not a single change or adjustment required.

* *Operates perfectly when pressure fluctuates*—throughout full pressure range.

SEE FOR YOURSELF

We will gladly send you a Sarco TD Steam Trap and strainer for 60-day trial. No cost or obligation. Advise size —⅜, ½, ¾ or 1"—and application. Sarco Company, Inc., Empire State Bldg., New York City.

2204-C

SARCO Thermo-Dynamic STEAM TRAP

THE MODERN TRAP THAT IS MAKING STEAM TRAPPING HISTORY!

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 216

Burndy Corp's four women engineers, left to right, Ruth Cerasoli, technical service; Grace I Wicks, design; Rose Feier Manfosky, patent applications; and Ruby S Langford, technical service

Power Lines

Once-wealthy Argentina, pickpocketed by Peron, is seeking economic health along the power road. From Buenos Aires comes word that the Water and Power Board is ready to buy 30 million dollars worth of power plant equipment; the same source reports that the government is considering a 280,000-kw atomic power station for B. A.

GE reports . . . "The first fully integrated turbine for boiler-feed pump drive has been successfully put into operation for the no. 6 unit at the Glen Lyn, Va., pawer station of the Appalachian Electric Power Co, a part of the American Gas & Electric system. Unit built by GE's small steam turbine dept is rated 6230 hp at 5610 rpm."

Unions lost the first round in the battle for engineers when Minneapolis-Honeywell engineers and technicians voted 'No' to organization. Defeat was bitter pill to United Auto Workers who had counted on this victory.

In two years, construction could get under way on a pressurized water plant with 200,000 to 400,000-kw capacity, according to Maj Gen K D Nichols, U.S.A. (Ret), atomic power consultant. Prediction that nuclear fuel could be competitive in the next decade clashed with estimate that nuclear and converted solar energy would be supplying only 10% of nation's power by year 2000, made by Wallace R Brode director, Nat'l Bureau of Standards.

After spreading doctrine of thrift to its customers for years, Alexander's Dept Store, White Plains, N. Y., proves that it can practice what it preaches. Store uses waste paper to fuel air conditioner, saves estimated $2000 yearly.

Ladies in the limelight

► IT LOOKS AS THOUGH management might go a-wooing. Like a roughneck schoolboy who's ignored the girls for years, the front office has been suddenly struck by the charm of the feminine gender. Impetus behind the budding romance is the current shortage of engineers.

Evidence of the new interest: Burndy Corp, a Norwalk, Conn. firm, has just hired its fourth woman engineer, and to mark the occasion, issued a news release praising the women on its staff and urging the measure as an antidote to the shortage.

Westinghouse has some words on the subject, too. According to one of its five women engineers, "America's growing shortage of engineering manpower can be eased by womanpower, but prejudices are keeping the girls out of the profession." Out of 120,000 women receiving degrees in 1956, only 62 were graduated in engineering. Why? Because instructors discourage an engineering career, and instead urge that the girls become engineering aides and assistants.

As if in defense of itself, education has launched its own investigation into the matter —announced a conference to consider the education of girls for careers in science and engineering. Conference, held at Arden House, Harriman, N. Y., was sponsored by the School of Engineering of Columbia University.

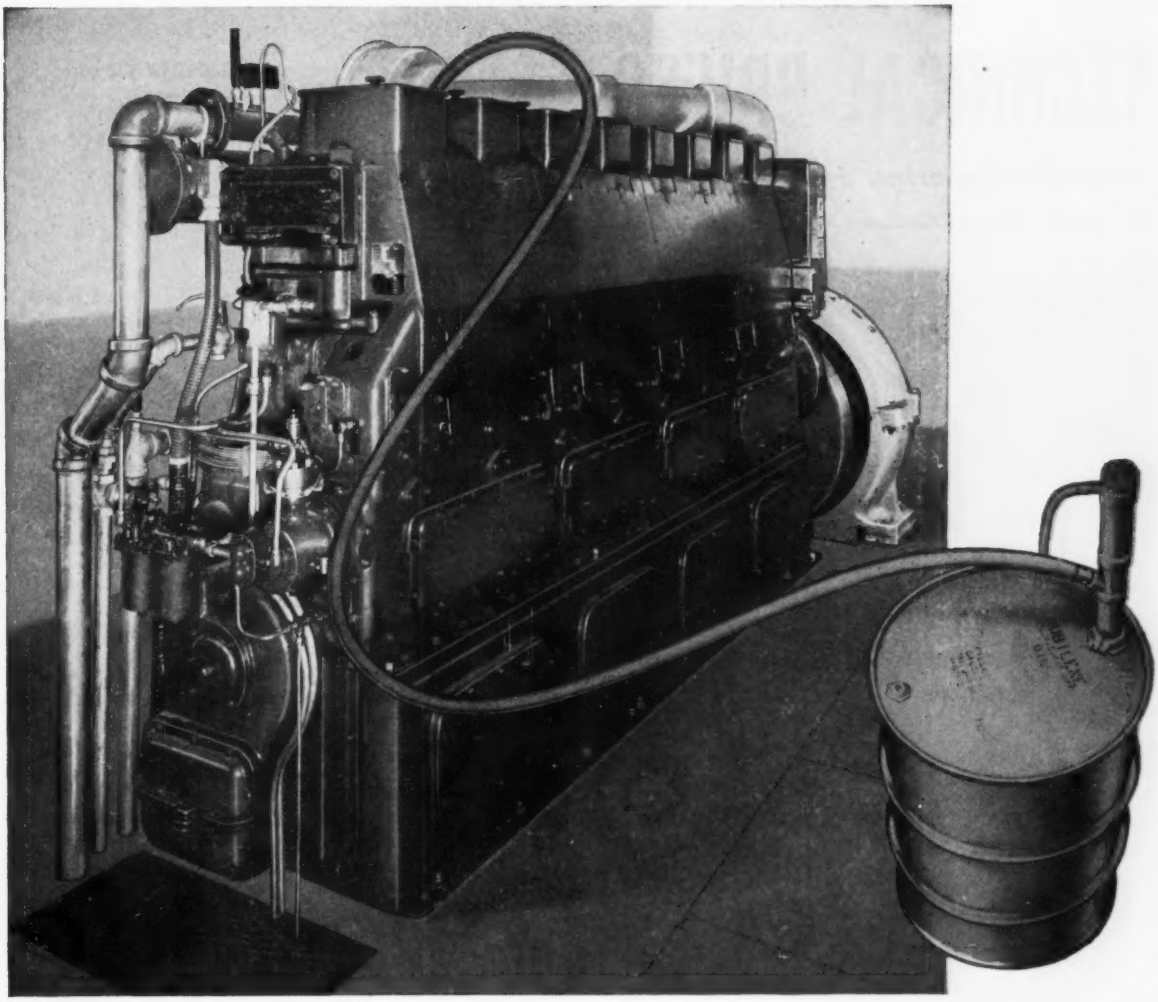
So, perhaps in the years to come, the hand that rocks the cradle may be equally at home with the slide rule. But no one wants to venture a guess. The ladies might cross everyone up and, finding themselves pursued instead of pursuer, lose interest in the chase.

New way to beat the heat

► THE LOT OF THE DESIGN ENGINEER, plagued by the problem of high temperature applications and low threshold materials, is considerably brightened by announcement of a new wonder material which keeps its strength at temperatures as high as 1300 F.

The new material, *Pyroceram*, is one of a family of basic materials, harder than high carbon steel, lighter than aluminum and up to nine times stronger than plate glass.

According to spokesmen for Corning Glass Works, *Pyroceram* can be tailor-made with thermal expansions ranging from slightly negative to high enough to match those of heavy metals. It can have electrical insulating properties superior to those of the (*Continued on page* 216)



Stops Thin-Out!

You can protect your Diesel against wear due to excessive thin-out of the lubricating oil at higher operating temperatures. Switch to Sinclair RUBILENE®, *the high viscosity index oil* proved by over 35 years in a wide variety of Diesel applications. You'll find RUBILENE holds its high film strength and reduces oil consumption . . . gives you better protection of cylinders, pistons, rings and other vital moving parts operating continuously for long periods. Your Diesel logs more full-power hours!

Switch now to RUBILENE. Regardless of the make of your Diesel, there's a member of Sinclair's famous RUBILENE or RUBILENE HD family that meets your needs exactly! Call your local Sinclair Representative or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation!*

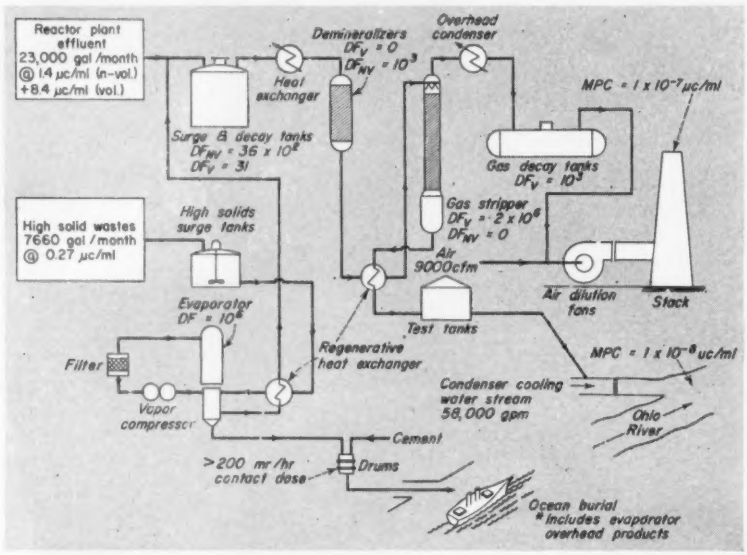
SINCLAIR

RUBILENE OILS

TECHNICAL BRIEFS

Latest engineering developments for busy power men

19 papers for you on
ATOMIC WASTES
NUCLEAR PLANTS
CORROSION
HYDRO


Reactor plant effluent 23,000 gal/month @ 14 μc/ml (n-vol.) +8.4 μc/ml (vol.)
Demineralizers DFV = 0 DFNV = 10³
Overhead condenser
Heat exchanger
MPC = 1 x 10⁻⁷ μc/ml
Surge & decay tanks DFNV = 36 x 10² DFV = 31
Gas decay tanks DFV = 10³
High solid wastes 7660 gal/month @ 0.27 μc/ml
High solids surge tanks
Gas stripper DFV = 2 x 10⁶ DFNV = 0
Air 9000cfm
Air dilution fans
Stack
Evaporator DF = 10⁶
Test tanks
Regenerative heat exchanger
MPC = 1 x 10⁻⁸ uc/ml
Filter
Condenser cooling water stream 58,000 gpm
Vapor compressor
Ohio River
Cement
>200 mr/hr contact dose
Drums
Ocean burial
* Includes evaporator overhead products

LIQUID WASTE DISPOSAL at Shippingport atomic power station is done principally by ion exchange. Gaseous wastes are decayed for 60 days, then diluted with air

Atomic wastes pose disposal problem

Control of radioactive material at the pressurized water reactor. *By J R Lapointe and R D Brown, Westinghouse Electric Corp.*

Extensive facilities have been designed and installed for control of the radioactive wastes from the nation's first large-scale nuclear power station at Shippingport, Pa. Since this is also the first design of a radioactive waste-disposal system for a large-scale power reactor, located in a populated area, considerable engineering effort had to be directed toward developing the disposal criteria, waste-treatment processes and controls for satisfactory waste disposal at this plant. The major results of this study and a detailed description of the waste-treatment processes are presented.

In determining which of the many disposal methods would be suitable, these factors had to be evaluated:

(1) Has the process been commercially proven or developed at least to pilot-plant scale? (2) Does the process provide a sufficiently high overall reduction in the activity level of the wastes to permit processed fluids to be safely disposed to the environment without exceeding specified tolerance levels? (3) Is the process economical? (4) Are the proper controls available to protect operating personnel and people in surrounding area?

Several different disposal methods for radioactive waste material are in use at the National Laboratories and other Atomic Energy Commission installations. Many other methods have been suggested. In general these methods can be classified into the following types: (1) natural decay (2) dilution and dispersion (3) land or sea burial (4) concentration and storage. An extensive study was undertaken to determine which methods were best suited.

The paper goes on to discuss the types of wastes encountered and the processes developed at the plant. *NESC paper No. 57-107.*

Directions for ordering papers on page 210

Structural features of the waste disposal system of the Shippingport Atomic Power Station, Shippingport, Pa. *By H T Evans, Stone and Webster Engineering Corp.*

The disposal plant for radioactive wastes at the Shippingport Atomic Power Station occupies more than an acre. Unlike the main plant, its design involved no unusual structural problems and the layout was not limited by structural requirements.

Cost of structural work is estimated at about 40% of the total cost of the waste-disposal plant. This is a considerably higher proportion than in the main plant and is much higher than usual for steam power stations and process plants in general.

Criteria governing waste-disposal facilities include the following:

(1) Tanks and pipes with contents which are or may be radioactive must be adequately shielded and are preferably installed underground.

(2) When tanks and pipes are installed underground, this must be done so no hidden leakage can develop which might result in undetected radioactive contamination of the local ground water.

(3) Conservative standards have been established for shielding the operating personnel and for rendering harmless all wastes released to the river or to air.

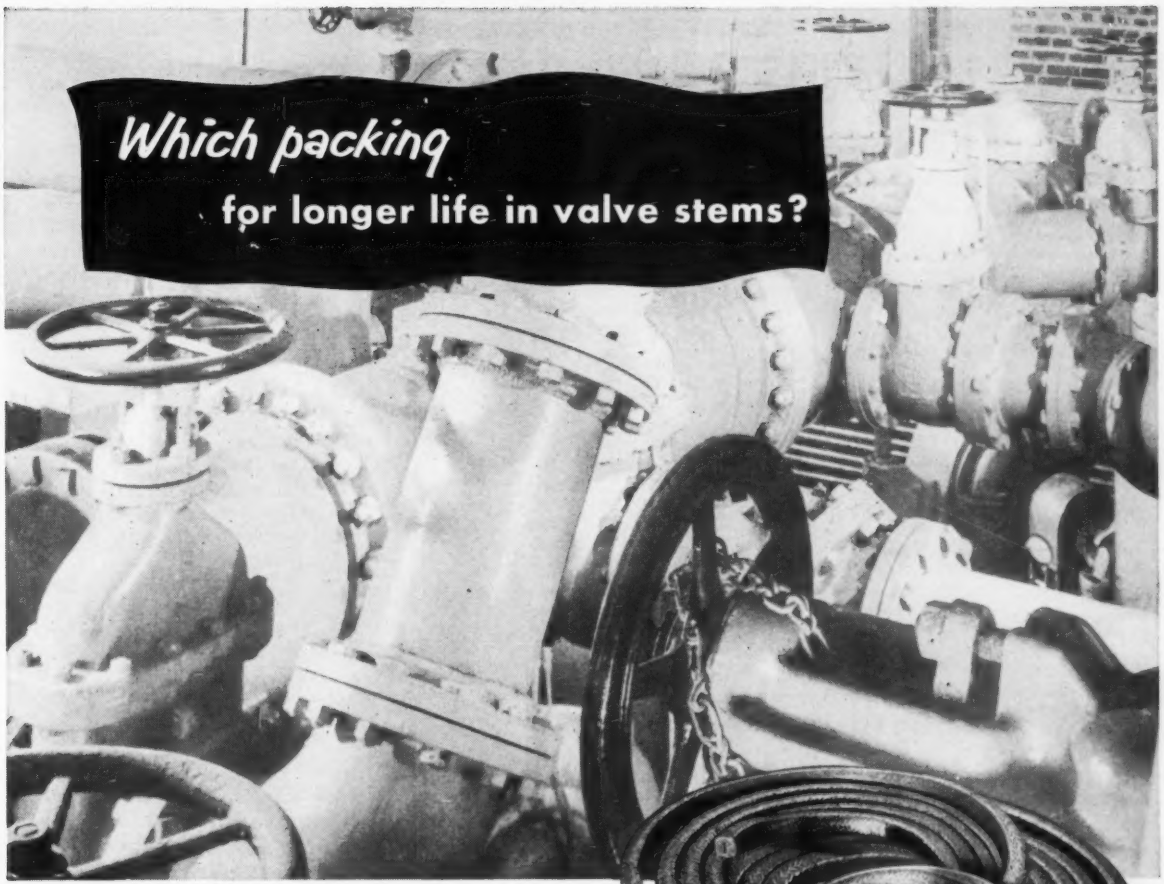
These criteria preclude the use of tanks and piping buried directly in the ground or embedded in concrete. These elements must be placed in vaults or chambers with space around them for monitoring and checking. *NESC paper No. 57-18.*

Nuclear waste economics—state of the art. *By E I Goodman, Nuclear Science and Engineering Corp.*

The wastes referred to in this paper are those, produced in nuclear fuel reprocessing plants, currently being stored in tanks. The economics of such wastes necessarily include consideration of steps such as:

(1) Method of treatment, e.g., solvent extraction, precipitation, ion exchange, etc (2) neutralization (3) evaporation (4) solids preparation by clay adsorption, drying, etc (5) storage (6) shipping (7) final disposal.

(*Continued on page* 150)



. . . for heavy fluids, steam, water and gas . . . *it's J-M Jewett®*

Strong, tough Jewett has been proven the ideal packing for heavy duty valve stem service against crude and heavy oils, tar, molasses and other heavy gummy fluids. It also provides efficient sealing against steam; fresh or salt, hot or cold water; air; gas and some chemicals requiring a packing free from rubber.

The basis of Jewett's exceptional durability is its construction of high-quality long fibre asbestos yarn with fine copper wire inserts. This yarn is braided over a lead ribbon core and formed square. Style 10 is treated with a heavy bodied, heat-resisting lubricant which won't bleed in valve stem service. Furnished graphited in coil or ring form in sizes from ⅛″ up.

. . . for superheated steam and gases to 900F *it's J-M High Temperature*

When valves are operating in high temperature service, your best packing choice is Johns-Manville High Temperature Style 398. It retains its resilience, holds a tight, lasting seal against superheated steam and dry gases under elevated pressures and temperatures up to 900F.

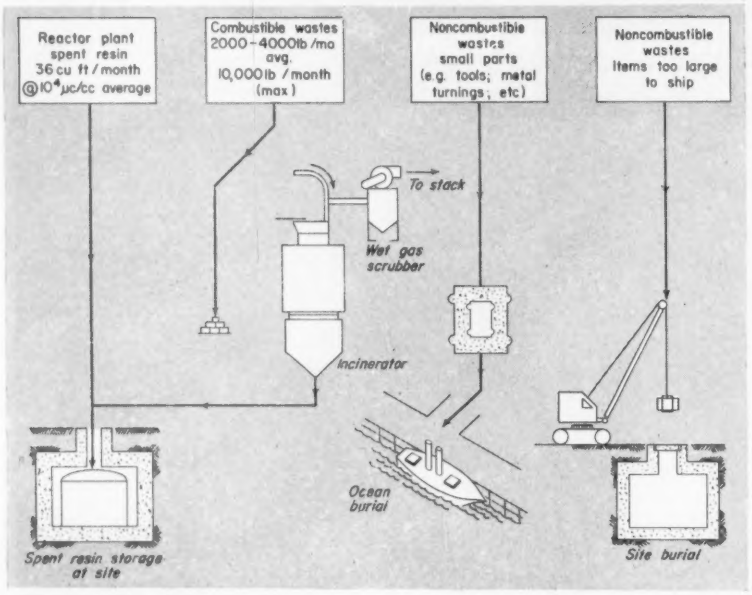
To obtain this high sealing efficiency, Johns-Manville braids asbestos yarn of high purity over a plastic core of special heat resistant composition. For extra strength, the yarn is reinforced with tough heat and corrosion resistant Monel wire. The packing is formed square and then lubricated with mica. Furnished in ring, coil and spiral form in sizes ¼″ to 1″.

Your local J-M distributor carries full stocks of Jewett, High Temperature and other packings. Call him today or write Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

More TECHNICAL BRIEFS

Begins on page 148


Reactor plant spent resin 36 cu ft / month @ 10^4 μc/cc average
Combustible wastes 2000 - 4000 lb /mo avg. 10,000 lb / month (max)
Noncombustible wastes small parts (e.g. tools; metal turnings; etc)
Noncombustible wastes Items too large to ship
To stack
Wet gas scrubber
Incinerator
Ocean burial
Spent resin storage at site
Site burial

SOLID WASTE DISPOSAL at Shippingport involves underground storage for spent demineralizer resin; incineration of combustibles; burial of noncombustibles

In considering waste costs, it is often unclear as to whether they apply to a single step or the overall treatment and disposal scheme.

On the basis of 8 mills per kwhr of electricity as the goal for economic nuclear power, approximately 1 mill per kwhr is assigned to chemical reprocessing of which 10% is designated as waste treatment and disposal costs. The thinking behind the above cost distribution is to bring down the cost of each segment of the nuclear power cycle to a level that permits economic power on an overall basis. It may be considered rather arbitrary at this point.

A great deal has yet to be accomplished in the waste economics field. *NESC paper No. 57-118.*

Disposal of fission products in glass. *By R W Durham, Atomic Energy of Canada, Ltd.*

A process for incorporating fission products and other waste material from the processing of burned out nuclear fuel elements into a silicate glass is undergoing development. Glass made from nepheline syenite with lime as a flux has been found to have a high resistance to the leaching action of water.

Incorporating fission products in glass is considered a possible approach to the problem of permanent fission product disposal. The glass product is quite resistant to water leaching and a preliminary cost estimate of the fixation process by the Process Economics Group of the Chemical Engineering Branch shows it will add only 0.06 mills per kwhr to the cost of nuclear power. It is not known, however, if the physical properties of the glass will be adversely affected by radiation and the increase in valence of a radioactive atom after beta emission. A long-term study is necessary to evaluate these effects. *NESC paper No. 57-54.*

Atomic waste disposal by injection into aquifers. *By E Roedder, U.S. Geological Survey.*

The author considers the mineralogical composition of natural aquifers (porous and permeable formations situated several thousand feet or deeper in the earth, below the potable water zone). He concludes that it would seem that raw acid aluminum nitrate wastes cannot be injected into ordinary aquifers without causing the precipitation of aluminum hydroxide gels, effectively blocking further injection.

By an exceedingly careful exploration, testing and selection of aquifers, and pumping procedures, it might be feasible to inject wastes through wells into deep aquifers under certain conditions. But there are numerous possible or probable technical difficulties inherent in the process, as well as the ever-present problem of high costs.

If high aluminum nitrate wastes are to be pumped into aquifers at all, the most likely solution to the problem of compatibility seems to lie either in (1) chemical processing of the waste to a form that will not readily precipitate upon injection into aquifers (2) in the use of an acid pretreatment of the aquifer to improve compatibility. *NESC paper No. 57-1.*

Stream surveys for radioactive waste control. *By E C Tsivoglou, E D Harward and W M Ingram, Public Heal h Service, Dept Health, Education and Welfare.*

Three distinct types of stream sample (water, mud, aquatic biota) are all important. Each yields information not derivable from the other two, and no one type should be neglected if an adequate interpretation in terms of the extent and effects of stream contamination is desired. Of the three types, the biological samples are perhaps the most difficult to obtain, but in estimating the effects and significance of stream contamination their importance is clear.

The duration of any individual survey depends on its importance and its major purpose. Much information can be obtained in a brief intensive survey of, say, ten days. On the other hand, seasonal variations of temperature, steam flow, predominant biological species, etc, may be important. Background radioactivity levels must be checked regularly and indefinitely to follow local and national changes and trends.

The same general principles apply to control of radioactive wastes as apply to control of other water pollutants. The stream survey is a key control device. *NESC paper No. 57-21.*

Radiochemical procedures for the identification of the more hazardous nuclides. *By B Kahn and A S Goldin, U.S. Public Health Service.*

The mere determination of the quantity of radioactivity in a medium is not an adequate measure of the damage or hazard that may be expected. Such damage can be estimated only on the basis of the biochemical and physical properties of the radionuclides present.

(*Continued on page* 200)

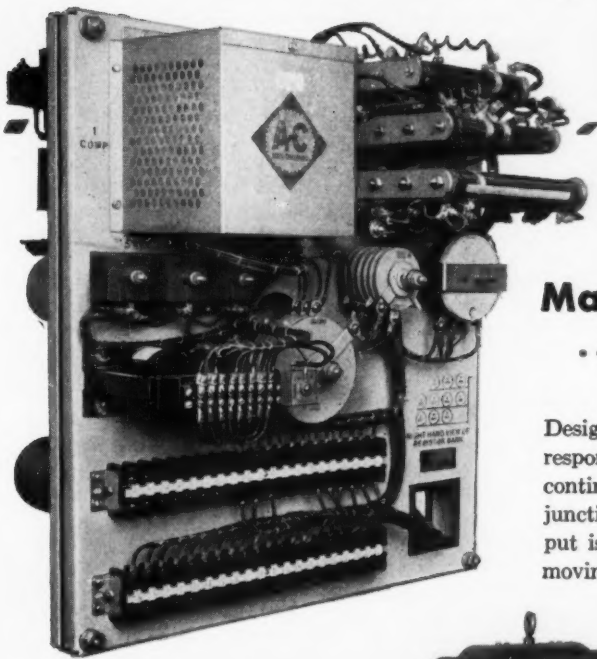
Directions for ordering papers on page 210

Small?

Medium?

Large?

A size and type for your specific needs



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Rocking Contact Regulators for voltage regulation of smaller ac and dc generators.

- Varies resistance in exciter shunt field by rocking action of contacts.
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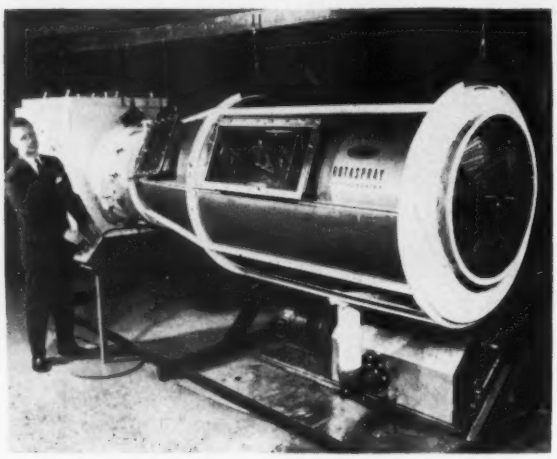


Air-conditioning system is self-cleaning

701 • New system of air conditioning for large industrial areas features a spray-type air conditioning unit. This central air conditioner is said to take only 1/3 the space of present equipment. It is also said to provide more accurate control of humidity and virtually eliminate system cleaning and maintenance.

New device is designed for overhead installation occupying waste space. It incorporates a spin-dry principle to remove water droplets, lint and other foreign matter. It makes use of a rotating eliminator and will operate at air velocities up to 2400 ft per minute. Because of the eliminator's rotating action, soaked particles are constantly thrown off by centrifugal force, making it completely self-cleaning.

Manufacturer claims that a major cost reduction provided by the system is the elimination of the many manhours normally required for cleaning.

Unit is produced in four sizes with capacities in the range from 10,000 to 30,000 cu ft of conditioned air per minute. Overall dimensions range from three to six ft in diameter and from 16 to 23 ft in length. Light in weight, units can be suspended from a ceiling, installed outside on a roof or hung from a wall. Construction of special protective shelters for outside installation is unnecessary.

Water, and all entrained particles from units, drains to a common collection and separation tank. One strainer station with a single pump serves an entire mill. This further reduces operation and maintenance costs, says manufacturer.

The recirculation pump strainer and reservoir, normally required for each processing area, are eliminated except for their use at the single separation plant. Water, makeup, overflow and treatment are handled at the one point.

Control of the new system is compared by manufacturer to the setting of a home thermostat. Two instruments, in middle of each processing area, are set for desired temperature. Complete details on request to the manufacturer.

Carrier Corporation, Syracuse 1, N. Y.

Refrigeration fitting does double duty

702 • Servicing instrument, combining moisture indicator and sight glass, has been designed to enable refrigeration service engineers or equipment owners to detect basic refrigeration system trouble in its earliest stages and prevent costly breakdowns.

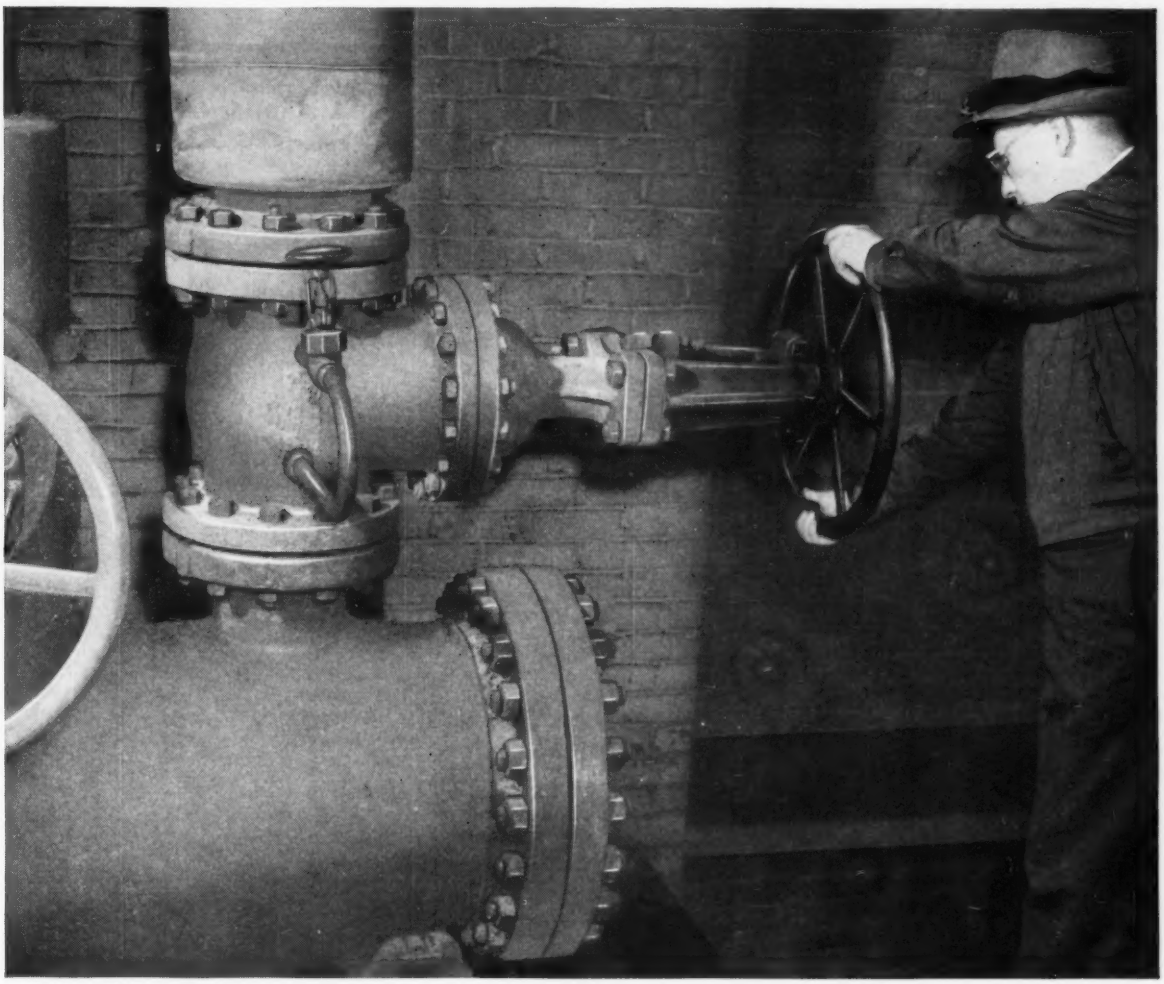
New unit has two moisture-indicating elements, one for Freon-12 and another for Freon-22 plus a built-in sight glass. The moisture-indicating element for Freon-12 shows blue in color when the refrigerant is dry and in safe operating condition—that is, when moisture content is below ten parts per million. When this element turns pink the refrigerant is dangerously wet, above 30 ppm. For Freon-22, the indicating element is green when dry (below 20 ppm); and pink when wet (above 25 ppm). The R-12 element works equally well with Freon-11, 113 and 114, says manufacturer.

Circular fused-glass window through which the moisture-indicating elements are visible also serves as a sight glass. Bubbles in the flowing refrigerant indicate a low refrigerant charge or restriction in the line. An important feature of the sight glass is its proven leak-proof characteristics. Request additional information from manufacturer.

Ansul Chemical Company, Marinette, Wis.

For more data on these items, use post cards on page 161. Identify your request with item number

Another Case of Cost-Saving with Crane Steel Valves



This valve has a 28-year service record

Here is another prime example of Crane valve dependability—and what it means in dollars and cents to the user.

This Crane cast steel wedge gate valve has seen more than 28 years of service. It is installed in a line from the steam header in the plant of Scott Paper Company's West Coast Division, Everett, Wash. The 8-inch, 300-pound valve is operated 2 or 3 times a week. After almost 3 decades of hard, continuous service on 450°F. steam at 250 psi., this rugged, precision-built Crane valve still closes tightly and easily. Yet it has required only routine maintenance.

From the outside, Crane valves may resemble others. The big difference is on the inside—where Crane quality in design and construction, in precision machining and superior castings, assures the low-cost, trouble-free operation you want. Call your Crane Representative for expert assistance in specifying and ordering.

You may spot cost-saving ideas in this book of "Valve Performance Facts"—32 case histories throughout industry. Ask your Crane Representative or write for a copy.

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More EQUIPMENT NEWS

Begins on page 152

Induction motors in 40 to 125 hp meet new NEMA standards

706 • New line of ac induction motors in 40 to 125 hp is built to new standards suggested by NEMA which assign a greater hp to a given motor frame size.

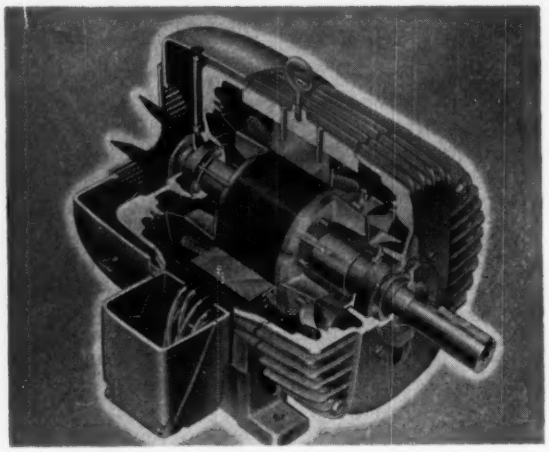
Weight reduction, compared with the former line, averages 20%, according to the manufacturer. In general, new models range from 100 to 500 lb lighter in comparable ratings. Lineal dimensions have been reduced an average of 10% and volume an average of 27%.

Weight and space savings have been achieved largely as a result of insulation improvements. Class A system includes a slot cell insulation with double-backed Mylar (Reg TM of DuPont deNemours Co) polyester providing greater physical and dielectric strength. Top sticks are made of nonhydroscopic Permafil glass with improved dielectric strength and higher heat resistance. Entire electrical system has a corona starting voltage well above operating voltage.

A completely enclosed cast-iron sealed-bearing housing in the endshield is designed to hold an optimum amount of grease. Larger capacity permits use of new type synthesized grease with a controlled bleeding rate. Drain plugs are from one-eighth to one-half inch larger than formerly to provide improved drain and grease relief.

In the open-dripproof design the one-piece cast-iron frame has a larger area enclosed than formerly. *Result:* The motor can be used in many applications which in the past had required a splashproof design.

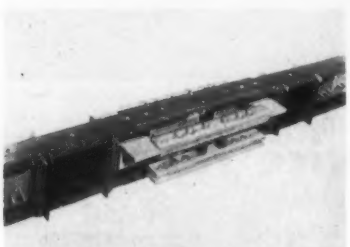
Double-end ventilation is provided to eliminate hot spots associated with straight-through ventilation. Air is drawn in from under both endshields, over the stator windings and out the protected air exhausts on both sides of the frame.



Manufacturer claims that one-piece cast-iron frame and endshields with a 20G shock rating are features of the entire line. Knock-off lugs, four on each endshield, are said to make the motor easier to disassemble for inspection.

The totally-enclosed fan-cooled model has been designed for maximum protection when used in chemical and other corrosive atmospheres. Write to manufacturer for full details.

General Electric Company, Schenectady 5, New York

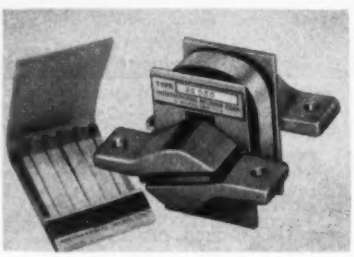


Aluminum feed-in duct

707 • Totally-enclosed feature of this feed-in duct is accomplished by separating and enclosing the aluminum bus bars in solid sheets of insulating material. This reduces cross action and results in an extremely low voltage drop and a high short-circuit strength that equals or exceeds NEMA standards on all ratings, according to maker.

Cable tap boxes are equipped with aluminum lugs that accept either copper or aluminum cable. Duct is available in standard ratings from 600 to 4000 amp, two, three and four pole.

Square D Company, 6060 Rivard St
Detroit 11, Mich.

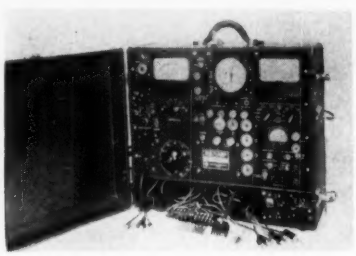


Paralleling reactors

708 • These units are designed to insure equal distribution of current loads to germanium rectifier junctions operating in parallel. They make possible very heavy current installations of germanium rectifiers formerly limited by the difficulty of matching junctions, according to manufacturer.

No derating of junctions is required when these reactors are incorporated in a circuit since they force each junction to share an equal current load. For complete information request bulletin SR-147 from the manufacturer.

International Rectifier Corp
El Segundo, Calif.



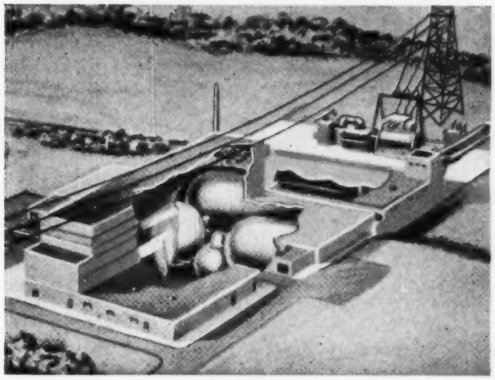
Self-contained test set

709 • Portable instrument features two independently adjustable current sources for testing differential and directional relays; a voltage output for voltage relays; an 8-volt dc output for testing relay targets and seal-in units; a 150/330-volt dc output for miscellaneous dc relay testing; continuity indicator for contact action and continuity tests; and separate 1% ac ammeter, ac-dc voltmeter and dc ammeter. Unit weighs 65 lb, measures 18x21x10½ in. It has a continuous duty rating of 0.4 kva. Request full details.

Multi-Amp Corp, PO Box 217
465 Lehigh Ave, Union, N. J.

For more data on these items, use post cards on page 161. Identify your request with item number

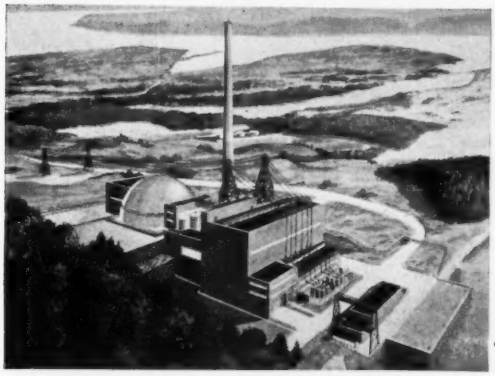
Three of America's LARGEST ATOMIC POWER PLANTS will use MAJOR COMPONENTS* by FW



60,000 KW SHIPPINGPORT PLANT
of the AEC and Duquesne Light Company

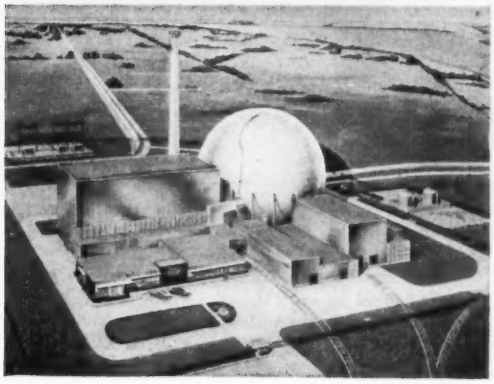
***Steam Generators.** Two of the four steam generators for America's first full scale commercial atomic power plant have been designed and fabricated by Foster Wheeler. They will convert heat from the pressurized water reactor into steam for operating the turbo generator.

***Pressurizer.** Also supplied by Foster Wheeler is the 18-ft high, 300 cu ft pressurizer used to maintain coolant loop pressure. It is designed for 2500 psig at 675 F and contains 342 electric immersion heaters for controlling operating pressure.



275,000 KW INDIAN POINT PLANT
of the Consolidated Edison Company

***Separately-Fired Superheaters.** Saturated steam from the pressurized water reactor will be superheated from 447F to 1000F by two Foster Wheeler oil-fired superheaters, each with a capacity of 1,075,000 lb/hr at 410 psia. Compared to operation with saturated steam direct from the reactor, addition of the superheat cycle will raise plant capacity from 163,000 kw to 275,000 kw and reduce estimated plant cost from $350 to $255 per kw.



180,000 KW DRESDEN STATION
of the Commonwealth Edison Company

***Primary Steam Separator.** Primary steam generated in the reactor will be separated from the water in a Foster Wheeler steam drum designed for a pressure of 1250 psia and capable of delivering 1,400,000 lb/hr at 1000 psia with a moisture content of not over 0.1%.

***Secondary Steam Generators.** Primary nuclear heated water will be converted to secondary steam for a reduced-pressure turbine stage by four Foster Wheeler steam generators with a combined capacity of approximately 1,190,000 lb/hr at 510 psia saturated.

IN addition to the above major nuclear components, Foster Wheeler know-how encompasses the design and fabrication of complete nuclear power plants of the aqueous homogeneous reactor type as well as specialized tank-type research reactors.

For further details on any of these items, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

More EQUIPMENT NEWS

Begins on page 152

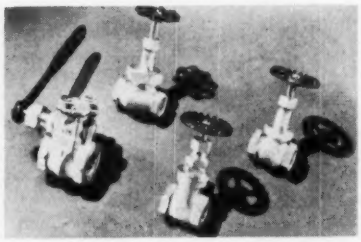
Valves combine advantages of carbon steel, stainless

710 • Welding advantages of carbon steel and seat wear characteristics at least equal to stainless steel are claimed features of these high-temperature instrument valves.

Wearing qualities are said to be improved over those of earlier carbon steel designs by incorporation of an integral seat insert of chrome-cobalt-tungsten alloy (arrow). As valve's body is carbon steel it can be welded into carbon steel pipelines with ease. Screwed ends are also available.

Precise flow control required for power-plant instrumentation and similar applications is provided by a tapered needle-point stem disk and fine pitch screw threads. Request bulletin 571 from manufacturer for details.

Edward Valves, Inc
East Chicago, Indiana



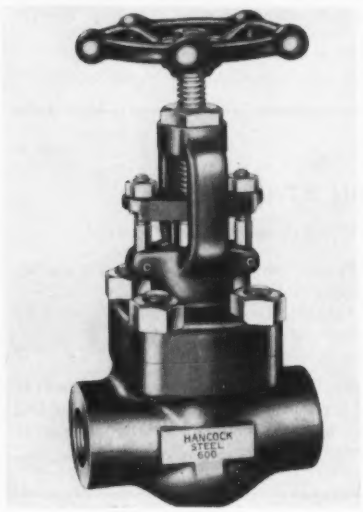
Heavy-duty bronze valves

713 • Line of bronze valves for commercial, industrial and original equipment application includes gate valves to 200 psi steam, globe valves to 300 psi steam, swing checks to 150 psi steam.

Each valve is fully tested, meets government specs and is provided with an identification disk, according to the manufacturer. Details on request.

Hammond Brass Works
Hammond, Indiana

Bolted-bonnet valves have integral or renewable seats

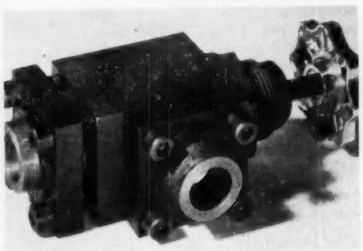


711 • These bolted-bonnet steel valves —in globe, angle, check, *Flocontrol* and high-pressure drop designs—are available with either integral hard-faced or renewable stainless-steel seats, depending upon type. They feature stainless-steel swing bolts, nuts, thread bushing and packing-gland followers. All valves have type-316 300-brinell stainless-steel stems.

Type 5520 valves, with renewable seats, can be supplied with alternate trim, body and bonnet materials.

Rated at 600 psi, these bolted-bonnet valves are designed to service public utility, petroleum, chemical and other industries. Sizes range from ¼ through 2 inch. Complete information available on request to the manufacturer.

Manning, Maxwell & Moore, Inc
Watertown, Mass.



Precision throttling valves

714 • Featuring low torque, units are available with 2, 1½ and 1¼ in. ported flanges adaptable to one basic body size; and 1, ¾, ½, ⅜ and ¼ in. ported flanges adaptable to another basic body size. Can be used with oils, fuels, other liquids compatible with aluminum and steel in central hydraulic systems, etc.

Greer Hydraulics, Inc, International Airport, Jamaica 30, N. Y.

Plastic ball valves available for corrosion service

712 • Compatible with standard fittings and piping methods, these plastic ball valves are designed to meet exacting requirements of modern fluid systems where corrosion problems exist.

Units are available with female threaded ends in ½ through 3-in. nps and are rated at 150 psi. Depending upon material, allowable temperature is over 200 F continuous duty. Request details from manufacturer or use handy Reader Service postcards on page 161.

Chemtrol Corporation, 1417 W El Segundo Blvd, Compton, Calif.

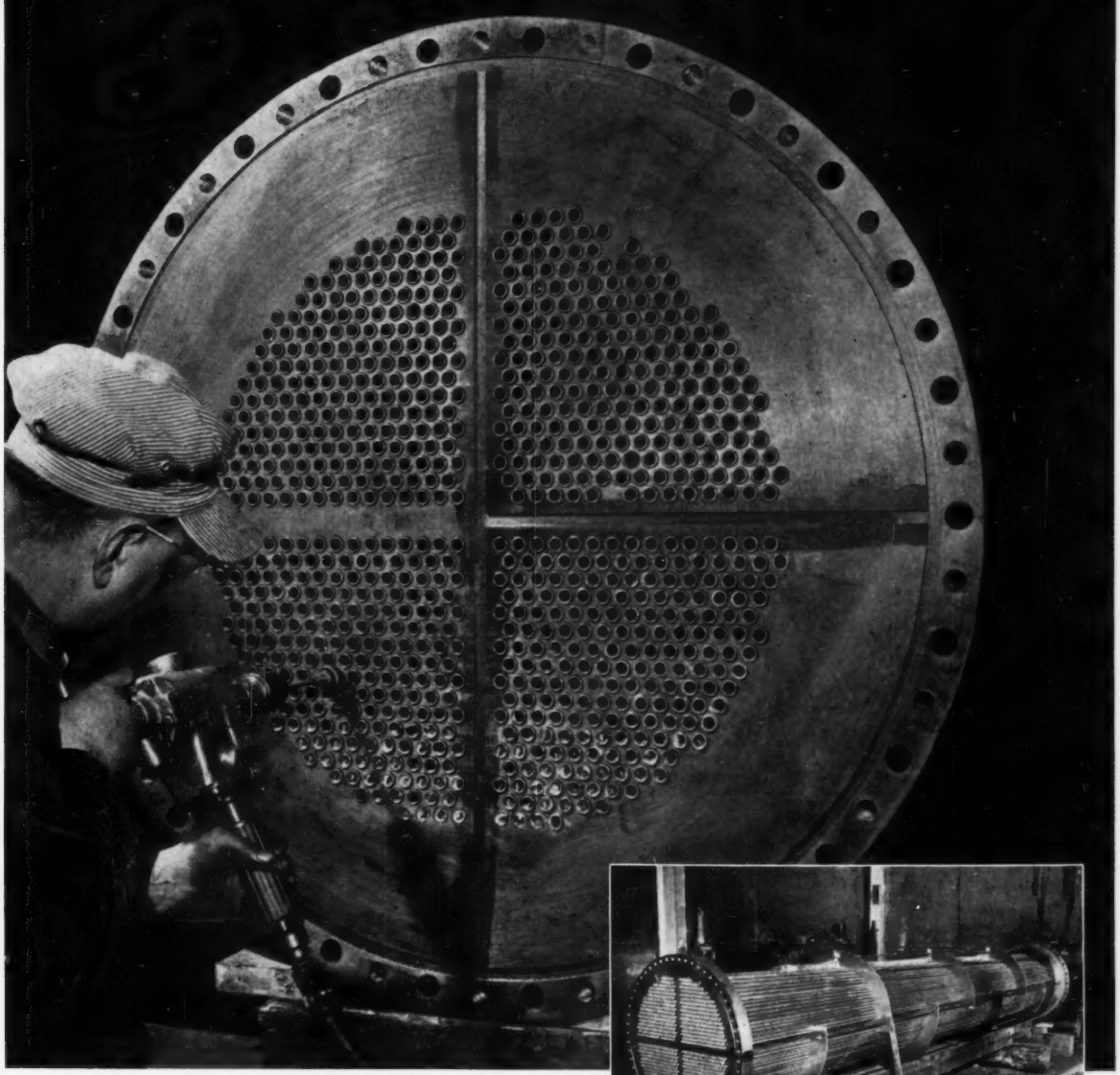
Stainless-steel solenoid valves

715 • Valves, for corrosive gases and liquids, are available in ⅛, ¼ and ⅜ in. pipe sizes with ports from 1/16 to ¼ in. Main feature, according to maker, is that valves have only 316 stainless steel and Teflon in contact with medium flowing through the valve, while maintaining packless feature.

J D Goulds Co, 4707 Massachusetts Ave, Indianapolis, Ind.

For more details on these items, use post cards p 161. Identify your request with item number.

Get your feed water heaters off to a good start

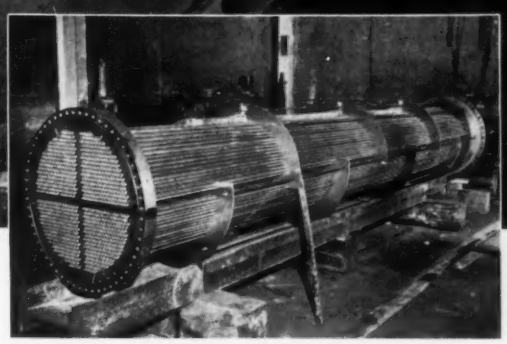


. . . tube with REVERE

Since no single alloy will be most reliable and economical under all various conditions encountered, the wealth of knowledge accumulated through Revere's Research Department is of vital importance to you.

For, over the years these specialists have compiled extensive data regarding the relative corrosion resistance of the different alloys under a wide variety of operating conditions. Why not take advantage of this storehouse of facts and consult with Revere's Technical Advisory Service before selecting the tubes for your equipment?

Revere also furnishes plates, from the smallest to the largest sizes, in Cupro-Nickel, Copper, Herculoy, Muntz Metal, Naval Brass and Admiralty, and tubes in Cupro-Nickel, Aluminum Brass, Admiralty, Herculoy, Arsenical Copper, Muntz Metal and other alloys.



REVERE 70/30 and 80/20 CUPRO-NICKEL tubes were used in high and low pressure feed water heaters designed and fabricated by CONDENSER SERVICE & ENGINEERING CORP., Hoboken, N. J., for Kent Avenue Station of the New York City Transit Authority.

REVERE COPPER AND BRASS INCORPORATED

COPPER * BRASS 18 01 * REVERE * ALUMINUM

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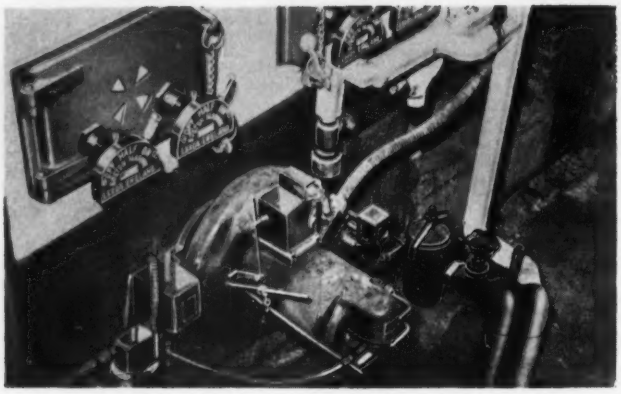
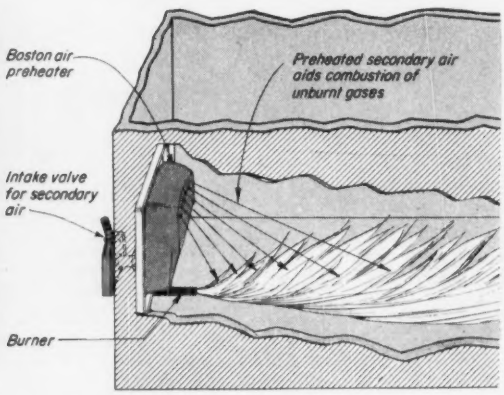
230 Park Avenue, New York 17, N. Y.

Mills: Rome, N. Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

More EQUIPMENT NEWS

Begins on page 152





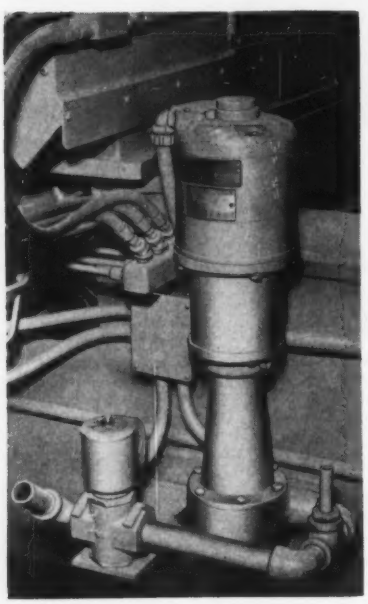
Air preheater reduces fuel costs, smoke and soot

716 • Fuel savings of up to 25% and a marked reduction in smoke and soot are claimed features of this air preheater. The unit which is usually installed in the fire door of the boiler, supplies preheated secondary air over the fire bed or burners for maximum combustion of fuel.

Designated the *Boston* air preheater, it consists of two basic sections: an adjustable air-intake valve that extends outside of fire door; and a preheating chamber made from a heat-absorbing alloy mounted on the inside of the door. Air is drawn through the intake by normal boiler updraft, circulates through a labyrinth of hot surfaces inside the preheating chamber, and is delivered evenly over the fire bed or burners at over 400 F. Preheating chamber is heated by radiation that would normally be lost, so it consumes none of fuel energy usable for boiler operation.

Unit can be used with low- or high-pressure oil-, coal- or coke-fired boilers of induced- or forced-draft or steam-blast type. It can usually be installed in one day, without interruption of service. Manufacturer states that because the preheater has no moving parts, outside of minor valve adjustments, it is free from the possibility of breakdown.

The Preheater Corporation of America, 415 Lexington Ave, New York 17, N. Y.



Circulating and coolant pumps

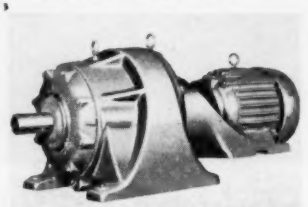
717 • Line of vertical *Motorpumps* are available in either sidewall mounted or immersion design. They have no stuffing box, no couplings, no pump bearings and no close running fits. As a result, manufacturer claims units are inherently free from maintenance. Long shaft construction permits high liquid levels. Vent holes provided high in the supporting head protect the motor should liquid level in column rise to excessive heights.

Sidewall mounted units are built in ¾, 1 and 1½ in. sizes with single discharge, also ¾ and 1¼ in. dual discharge units. Horsepower range is ¼ to 5 with deliveries to 180 gpm at heads to 90 ft.

Immersion types are built in ¾ to 3 in. discharge sizes with a horsepower range from ¼ to 10 and deliveries to 500 gpm at heads to 160 ft.

Ingersoll-Rand Co, 11 Broadway New York 4, N. Y.

Don't miss this item . . .



Packaged power unit . . . . . p 166

. . . or other product news appearing on following pages

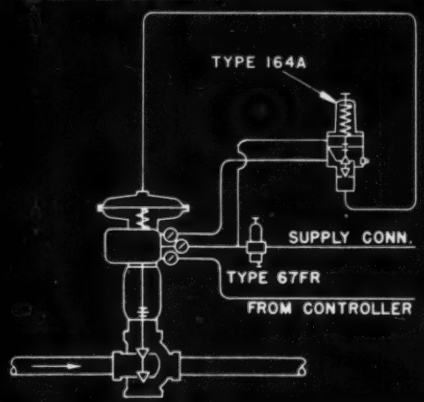
Vibration monitor system . . p 166
Self-priming pump . . . . . p 168
Stainless steel thermostat . . p 168
Control time switches . . . . . p 170
Dual gravity traps . . . . . p 171
Two-stage compressor . . . . p 171
Air-operated controller . . . p 172
Diesel safety switch . . . . . p 172
Variable delivery pump . . . p 174
Lubrication fitting . . . . . p 176
Friction power take-off . . . . p 178

For more data on these items, use post cards on page 161. Identify your request with item number

FISHER® SERIES 164

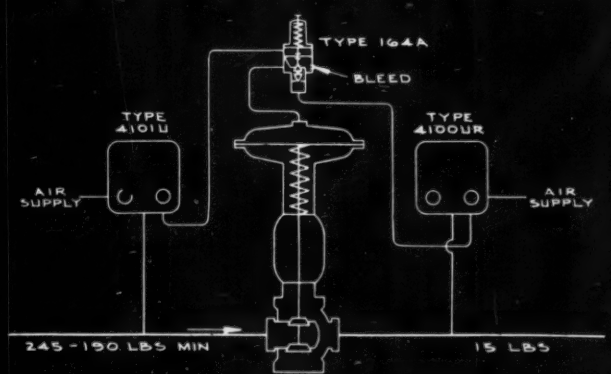
For "Gadgeteering" Control SUCH AS

TWO-WAY ACTION for SAFETY LOCK-UP

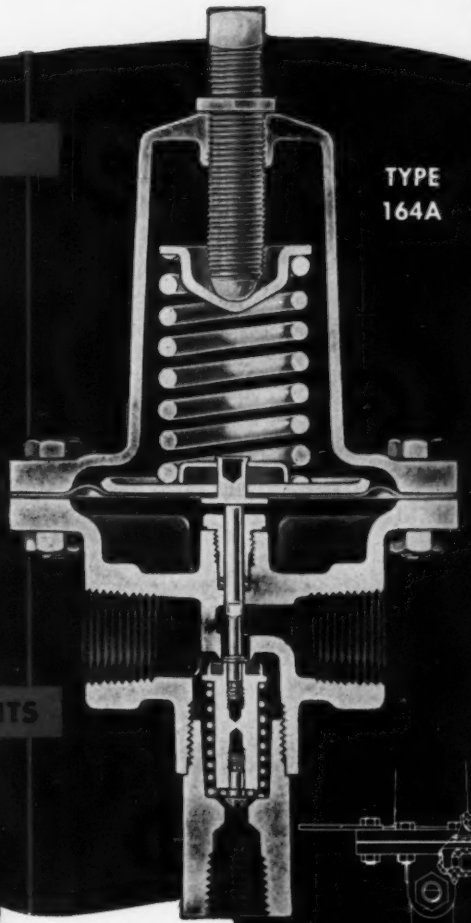


Lock-up system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will be held in position at time of supply pressure failure.

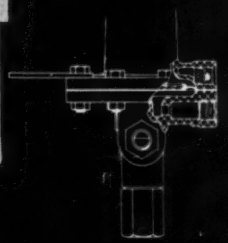
or THREE-WAY ACTION for SWITCH AIR CIRCUITS



Pressure reduction normally handled by 4100UR Wizard. If inlet pressure to main valve falls below a predetermined amount Type 4101U snap-acting Wizard bleeds pressure off Type 164A switching valve causing 3-way valve to change position so as to close control line pressure and bleed main valve diaphragm pressure to atmosphere. Main valve will stay closed until inlet pressure is restored to desired amount.



- SMALL
- COMPACT
- SELF CONTAINED



Side view of Type 164 Showing ¼" Control Line Connection. Control Chamber is separate from body chamber.

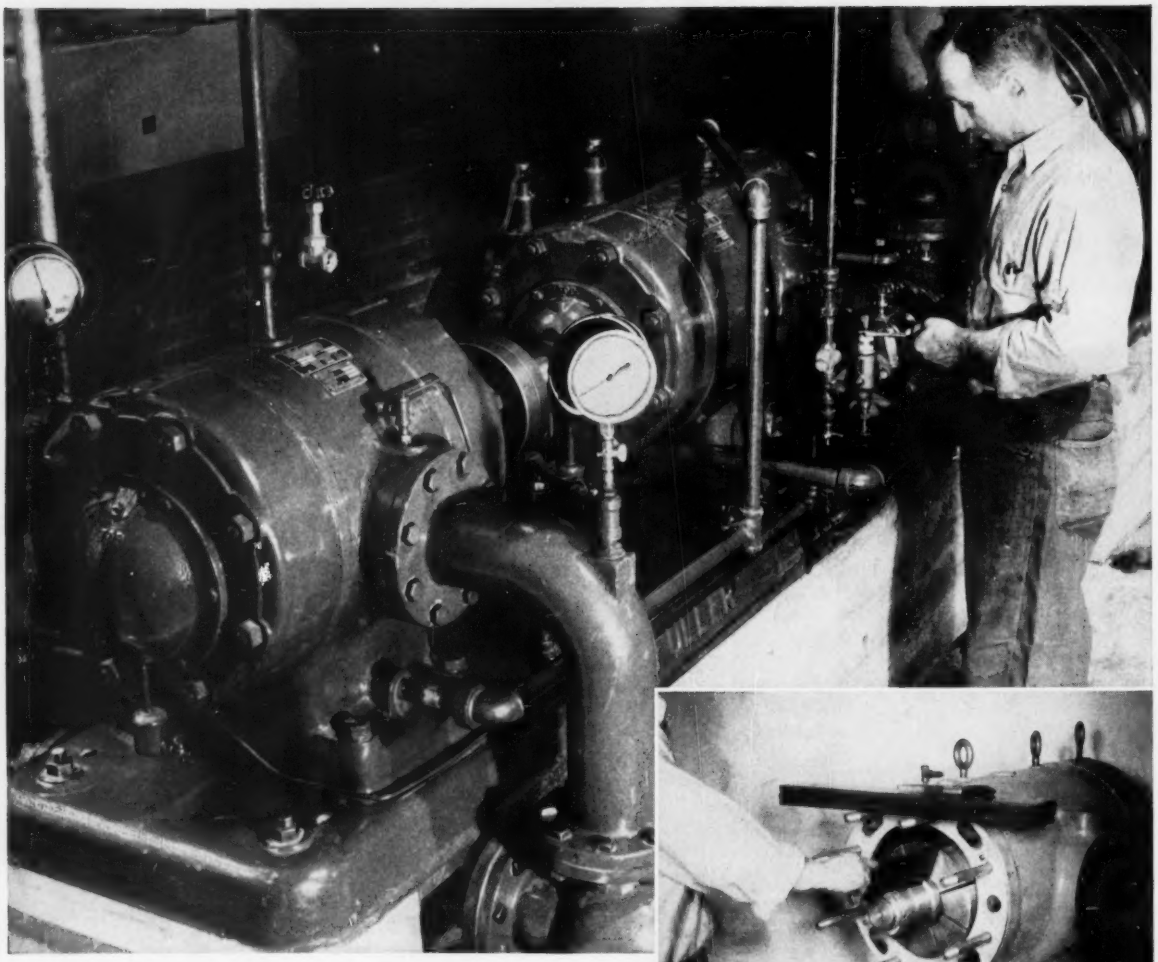
SIZES ¼" or ½"

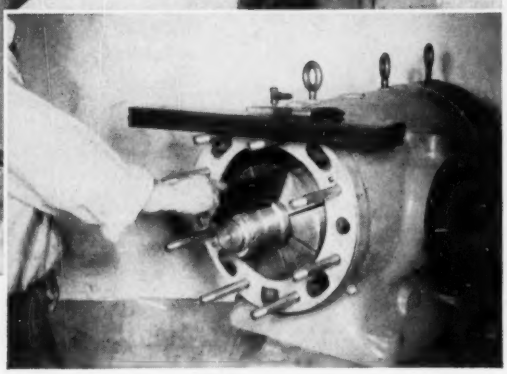
CONTROL SPRING RANGES PSI	PRESSURE CHANGE ON DIAPHRAGM FOR FULL VALVE STROKE, PSI
3 to 15	2
5 to 20	2½
5 to 35	4
30 to 60	5¾

MATERIALS

Zinc die cast body and spring case, composition diaphragm and valve disc.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA
CANADIAN PLANT: WOODSTOCK, ONTARIO
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL





Blade inspection

PERFECT COMBINATION OF MEN AND MACHINES

Providing plant air for varied uses imposes heavy responsibility on both the compressor and its operator to keep production moving.

The simplicity of the Fuller Rotary Compressor principle reduces maintenance to an absolute minimum; by the same token, operator's universal pride in Fuller Rotary performance contributes to longer life of the compressor. Few moving parts and smooth operation limit the operator's work to periodic inspection.

This perfect combination of men and machines is worth investigating, with an eye to economies you, too, can enjoy. Write to Fuller Company, compressor sales department for detailed information.

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126 Bridge St., Catasauqua, Pa.
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New free bulletins are listed and numbered, beginning on back of this page. To order those you want, write POWER item number here → — *do not use manufacturer's bulletin number.*

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AIR CONDITIONING, VENTILATING

1 **Air filtration** is subject of 4-p illustrated bulletin 120. Shows comparable efficiencies of filter types, defines high-efficiency filtration and includes information on filter selection. Lists applications. Cambridge Filter Corp, 738 E Erie Blvd, Syracuse 3, N. Y.

2 **Centrifugal collectors** are subject of 6-p illustrated folder. Contains specs, dimensional drawings and selection information. The Kirk & Blum Mfg Co, 3233 Forrer St, Cincinnati 9, Ohio.

3 **Utility sets** are described in 28-p illustrated bulletin 8414. Contains selection information, capacity tables and specs. Also includes dimensional data, charts and tables. American Blower, Detroit 32, Mich.

4 **Cooling towers** are subject of 32-p illustrated bulletin CT-57-1. Lists advantages. Describes construction and operation of all major parts, effects of recirculation and surroundings. Includes data sheet, drawings and charts. Foster Wheeler Corp, 165 Broadway, New York 6, N. Y.

BOILERS AND AUXILIARIES

5 **Retractable soot blowers** are described in 5-p illustrated bulletin 1030. Contains cross-sectional drawings and lists design features. Copes-Vulcan Div, Blaw-Knox Co, Erie, Pa.

6 **Boiler-burner** units are subject of 3-p bulletin 900. Contains diagrams, cutaway drawings, and specs. International Boiler Works Co, 660 Willow St, East Stroudsburg, Pa.

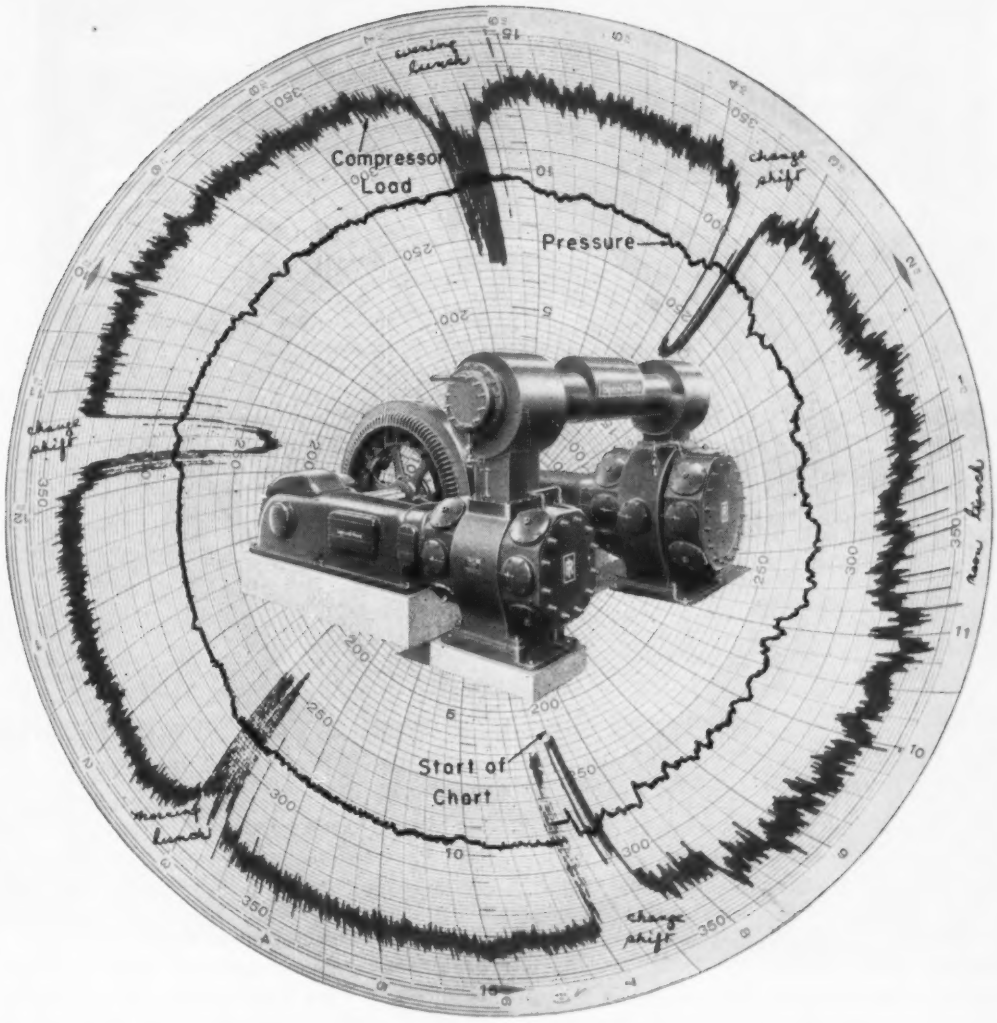
7 **Boilers** are described in 8-p illustrated bulletin AD-162. Includes cutaway drawings, information on design features and specs. Cleaver-Brooks Co, 326 E Keefe Ave, Milwaukee, Wis.

8 **Mortar preparation,** placing procedure and general instructions for gun-applied linings is contained in 24-p illustrated bulletin. Includes bibliography of refractory concrete. Universal Atlas Cement Co, 100 Park Ave, New York 17, N. Y.

9 **High-temperature refractory mortars** are described in 6-p illustrated bulletin 600. Contains illustrations of tests and applications as well as products. Provides general and technical data on 11 regular and special grade mortars. J H France Refractories Co, Snow Shoe, Pa.

10 **Steam generators** are described in 68-p illustrated bulletin B-56-5. Covers large central station and industrial installations including reheat and dual circulation. Foster Wheeler Corp, 165 Broadway, New York 6, N. Y.

(*Continued on page* 192)



AROUND THE CLOCK

with an Ingersoll-Rand PRE Compressor

Heavy 24-hour loading like this is all in a day's work at Caterpillar Tractor Co.

An air compressor doesn't punch a time clock. But the 24-hour pressure-capacity chart shown above gives an even better record of its actual, on-the-job performance at Caterpillar Tractor Co., Peoria, Ill.

This chart was taken on a nine-year-old PRE compressor supplying 3330 cfm at 95 psi for general plant air. Except for a slight "breather" during changing of shifts, this heavy-duty compressor is called upon to deliver full rated capacity virtually 24 hours a day — month after month, year after year.

This compressor is one of eight PREs (total capacity 24,640 cfm) in round-the-clock service at the Caterpillar plant. The first PRE unit was installed here in 1927 and, like all the rest, is still giving efficient, dependable performance under full load conditions.

For proved dependability like this, in continuous heavy-duty service, it pays to specify Ingersoll-Rand compressors. Ask your I-R representative to give you the complete story.

PRE compressors, 400 to 3000 hp, use I-R Channel Valves

Ingersoll-Rand

I-567

11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS

George Edwards

believes that you make your own breaks

► WHILE I WAS MOWING our front yard one evening last week, the brakes slipped on a heavy truck parked about thirty feet from my next door neighbor's car. Our street has a slight grade and the truck fetched up against the car with a solid "clunk."

Neighbor Don Cameron—who's a retired Navy chief machinist mate—the truck driver and I looked over the car. It wasn't damaged and we all said how lucky it was that the truck wasn't going very fast.

While finishing the grass, I mulled over the forces in action when the truck hit the car. We normally think of them as physical forces involving moving objects. But they're more than that. In a figurative sense they can make the difference in what people do with their lives.

My thoughts turned to the young fellows who are coming out of school this year. At first glance, this may seem like a weird mental broad jump, but it really isn't. You don't have to be an Einstein to know that weight and speed cause *impact*. The truck had weight but no speed. Consequently it didn't make much of an impression on Don's car.

This is just as true of the way a man goes about his job as it is of moving objects. If a guy wants to make an impression on the outfit he works for, he's got to put some zing into as much weight as he can muster.

I'm not talking about the fellow who tries to throw his weight around. He's not kidding anybody but himself. Nor do I mean the man who goes off halfcocked—rushes around in a big hurry, but doesn't know the facts. He only piles one snafu on top of another.

How *does* a man get the weight he needs? I don't think there's any other way except by staying on the ball. When a guy *knows* what he's talking about, his words have weight; people listen. Couple this with his ability to get a job done in the least possible time and you've got *impact*. This fellow makes an impression on those around him.

Practically all of the young fellows starting to work this summer—those with engineering degrees and those from trade schools—can pick and choose their jobs. The country needs engineers and skilled workers today as never before.

Even so, this doesn't mean that the new men are going to coast up the ladder just because they show up at the plant every day. The guys without drive probably won't have to worry too much about losing their jobs, but they're going to see slots above them filled by other men as time goes by.

The men who move up are the ones who've combined weight and speed to produce an impact that the boss can't afford to overlook.

This system has been with us for a long time and it'll stay this way. Take a look at the successful men in any field today. You'll find that they've got one thing in common, *know-how* and *drive*. And you'll find, too, that they're familiar with an item known as *hard work*.

Plant adds $440,000 operating credit when Dowell cleans "problem" superheater – chemically!

Here's how a modern plant overcame a serious and potentially costly maintenance problem.

Scale deposits were causing tube failures in the superheater of a 175,000 pound-per-hour boiler. To clean the tubes mechanically and replace them would require 14 days of *unscheduled outage* time. In dollars and cents this meant $40,000 per day of lost throughput for the company.

To complicate the problem further, the superheater was a non-drainable type.

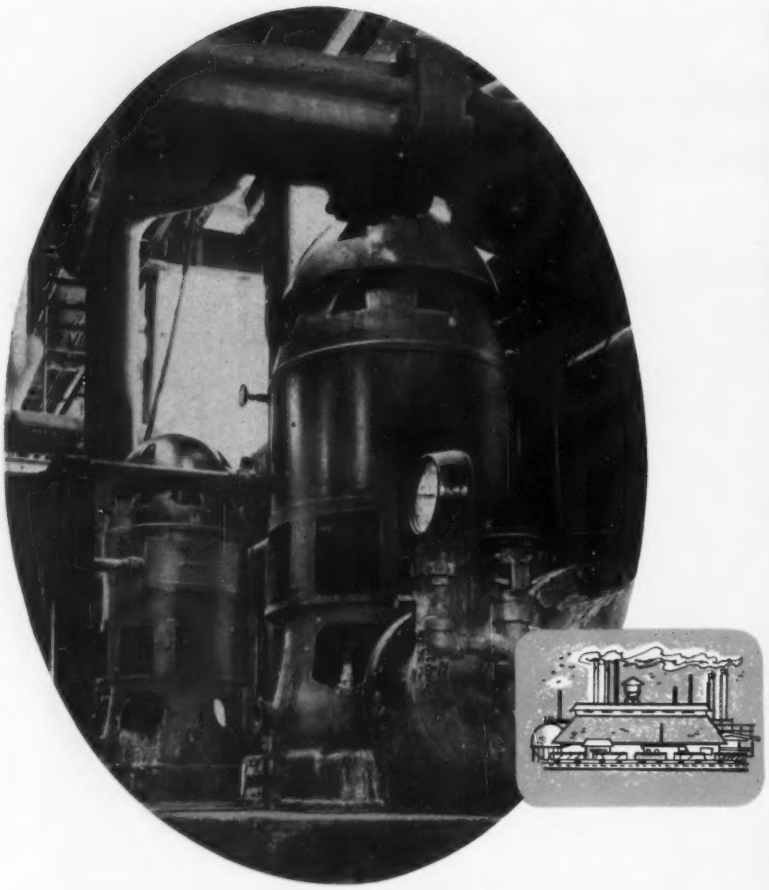
Dowell engineers, using their wide experience in the chemical cleaning of various types of equipment, developed a special cleaning technique for this type of superheater. Dowell provided all the pumping and control equipment, trained personnel and chemicals to do the job, and *restored the unit to top operating efficiency in 3½ days.*

Whether your cleaning problem involves simple units—or complex pieces of special equipment, Dowell has the facilities and experience to solve it. Versatile Dowell Service has proved itself in many industries—for example: chemical, construction, paper, petroleum, steel.

Find out today how Dowell chemical cleaning can help your plant to greater profits. Call the Dowell office nearest you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically **DOWELL**

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY



Verti-Line®

PROCESS PUMPS

in

COOLING SYSTEM

At the Brea Chemical Company in Southern California two 50 HP Verti-Line process pumps are handling 1800 GPM at 105°F, returning water from the ammonia synthesis area to cooling towers. *These units have been operating 24 hours a day since May, 1954 – without maintenance expense other than normal service.*

Over 100,000 satisfied vertical pump users agree there's no pump like Verti-Line for low first cost, economical operation, and negligible maintenance.

Send for new brochure, "PUMPS FOR SALE". Ask for Bulletin 1-67

LAYNE & BOWLER VERTI-LINE PUMPS

IF YOUR NEEDS INCLUDE PROCESS PUMPS, IT WILL PAY YOU TO INVESTIGATE VERTI-LINE BEFORE YOU BUY

Verti-Line Pumps are exclusive products of

LAYNE & BOWLER PUMP COMPANY

general offices & main plant

2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

More EQUIPMENT NEWS

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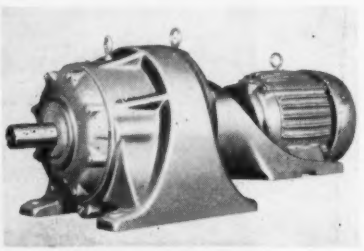


Gear unit

720 • Packaged power unit meets JIC requirements for operations that require a standard NEMA motor mounted separate from the gear unit. Unit uses a heavy-duty cast-iron motor support to provide easy access to the motor mounting and coupling.

In industries that carry a spare motor inventory, unit is said to be suited to various operations that require flexibility and quick motor replacement.

Motor replacement is reportedly easy and change is not limited to the original type of motor. If requirements change, manufacturer states that any enclosure of the same NEMA dimensions and rating may be used.

Speed ranges are from 37 to 280 rpm and hp ratings are from 1 to 30.

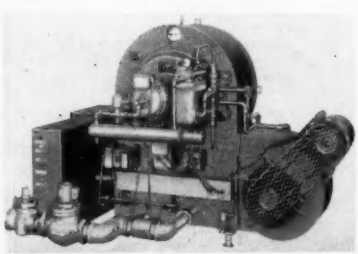
U.S. Electrical Motors, Inc.
Box 2058, Terminal Annex
Los Angeles 54, Calif.

For more details on these items, use post cards p 161. Identify your request with item number.

Speed reducer

725 • Shaft-mounted unit is suited for many applications where complex multiple reduction belt or chain drives have been required. It offers flexibility of mounting arrangement, increased safety, and lower maintenance expense. It is said that ratio changes can be made in minutes simply by changing pulleys. Variety of pulley sizes makes this unit adaptable to a broad range of speeds.

General Electric Co, Schenectady, N. Y.



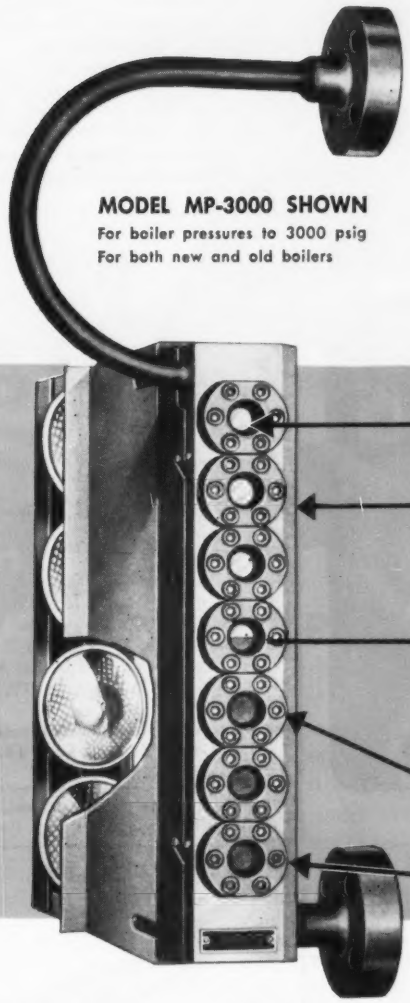
Vibration monitor system

728 • Non-electric system is said to be sensitive to increases in vibration yet to ignore both starting vibration and transient shocks normal to operation.

System combines malfunction detector, for mounting on protected equipment, and

MORE THAN ~~950~~ 1400 DIAMOND MULTI-PORT GAUGES

In use and on order for over ~~240~~ 300 Central Station Generating Plants



MODEL MP-3000 SHOWN
For boiler pressures to 3000 psig
For both new and old boilers

SMALL ROUND PORTS INSTEAD OF LONG GLASS AND MICA STRIPS

GAUGE NEVER REMOVED FROM BOILER FOR GASKET CHANGES OR OTHER NORMAL MAINTENANCE

STEAM SHOWS RED
WATER SHOWS GREEN

Also available is Model MP-900 for boiler pressures to 900 psig

COMPLETE PORT CHANGE REQUIRES ONLY ABOUT 15 MINUTES

EACH PORT THERMALLY INDEPENDENT

Because the Diamond Multi-Port solves the problems inherent in water level gauges on boilers operating at high temperatures and pressures, it has had rapid and wide acceptance. In addition to the 1400 for central station generating plants, more than 150 have been sold to industrial power plants.

Advantages of the Multi-Port are many. In addition to those shown above, it has maximum thermal stability for rapid starting . . . "Hi-Lite" illuminator for improved readability . . . welded construction for permanent tightness . . . end stems can be furnished instead of flanges . . . startling reductions in maintenance costs.

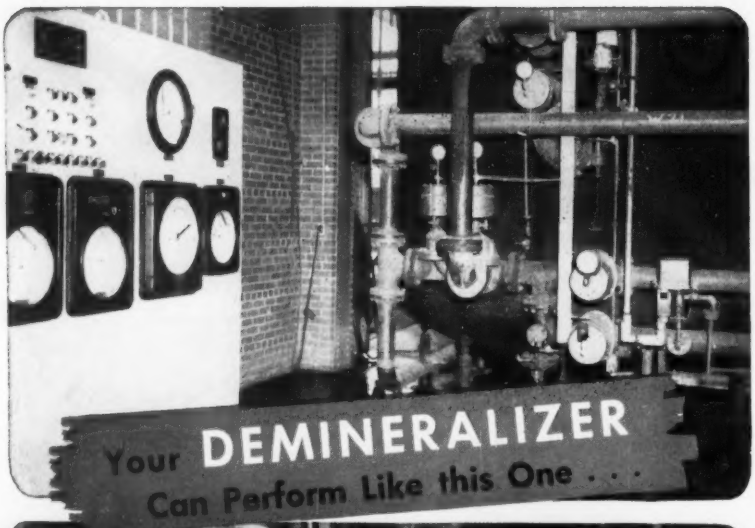
Write for Bulletin 1174U (Model MP-3000) or Bulletin 2044U (Model MP-900) for more information.

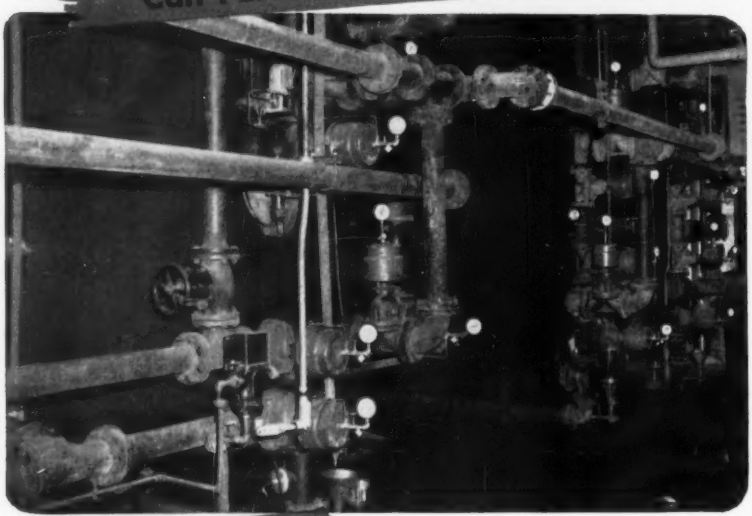
7801

Diamond

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO • DIAMOND SPECIALTY LIMITED — *Windsor, Ontario*





with Nalcite* HCR

HIGH CAPACITY
HIGH TEMPERATURE
ION EXCHANGE
RESINS

500 gallons per minute of clarified Missouri River water are completely deionized for 100% make-up to a 1250 psig boiler by this Nalcite-charged unit at a large Midwestern utility. Whether your water conditioning problem is large or small, Nalcite HCR cation exchange resin, together with either Nalcite SAR or SBR anion exchanger gives you performance that means longer on-line operation, with removal of both strong and weak acids including silica.

Full information on Nalcite Ion Exchange Materials is yours for the asking. Write today.

*Reg. Trademark of the Dow Chemical Company

Nalco®

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

PRODUCTS • *When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.*

More EQUIPMENT NEWS

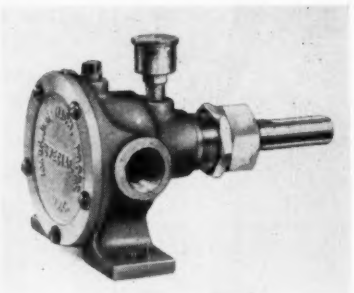
Begins on page 152

control unit which is wired to detector through ¾-in. conduit.

Malfunction detector is designed for use in Class I, Group D; and Class II, Groups F and G locations. Control unit is oil tight and is installed in a non-hazardous location unless connected with an airline using an optional air purge fitting.

Applications include the protection of pumps, motors, blowers, compressors, centrifuges, engines, turbines and other costly equipment. Details from manufacturer.

Robertshaw-Fulton Controls Co
2920 N 4th St, Philadelphia, Pa.



Impeller pump

727 • Unit is self-priming and is said to operate quietly and effectively in either direction at high or low speeds. Will operate from a motor as small as 1/3 hp single phase. Handles all liquids that do not affect bronze or neoprene, at 7½ gpm, 10 psi at 1750 rpm.

American Machine Products, Inc
172 Centre St, New York 13, N. Y.

For more details on these items, use post cards p 161. Identify your request with item number.

Stainless steel thermostat

735 • Unit is said to be suited for service in 5% H_2SO_4 at temperatures up to 120 F (or in higher concentrations at lower temperatures), acetic acid vapors, halide solutions, alkaline solutions, and other materials to which 316-type stainless steel is resistant.

Unit is supplied with coupling head mounting having a ½-14 pipe thread for direct threading into a tank or pipe wall. Contacts open above the control setting. Control temperatures are adjustable over a range of −100 to +400 F, and short-time overshoot by as much as 100 degrees will not affect reliability according to manufacturer. Current rating is 10 amps, 115

new pressure switch

...has the appearance and performance you need

Looking for something new, something better, to control or limit the pressure of air, gas, oil? Use this new Honeywell Industrial Pressure Switch . . . designed to complement the most attractive equipment or panels . . . constructed to give lasting performance in the most rugged applications. Use it to make your equipment more automatic, improve your system, provide trouble-free service.

Here are the facts you'll want to know:

- Designed for flush or surface mounting
- Die-cast case is dust and corrosion resistant
- Visible mercury switch position (SPST or SPDT)
- Front-of-case set-point and differential adjustment
- Selection of pressure ranges to 3000 psi
- Specifically designed and constructed for industrial use . . . ½" pipe connection
- Available in explosion-proof construction

For complete data, a consultation on applications, prices for any quantity . . . get in touch with your local Honeywell sales engineer. He's as near as your phone. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Specification sheet S1011-3 "New Honeywell Industrial Pressuretrol"

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

14"
Fact 1
Once in a while a better product is made, and made so well, that it becomes the standard by which all similar products are judged.
RIGID
HEAVY DUTY
Every RIGID Pipe Tool TESTED individually before shipment
Fact 2
The preference that you and millions of other users have shown for the RIGID Pipe Wrench puts on us the responsibility of keeping it always up to the top quality you expect of it.
The Ridge Tool Company, Elyria, Ohio, U. S. A.

More EQUIPMENT NEWS

Begins on page 152

volts ac, or 2 amps, 115 volts dc. Cartridge is ⅝ in. in diameter and has an immersed length of 3 in. According to manufacturer, unit will control within 2 F in a well-designed system. Details from manufacturer.

Fenwal, Inc, Ashland, Mass.

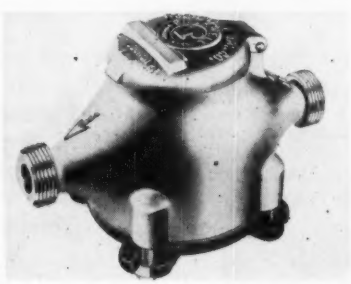
Control time switches

722 • These three off-peak switches are designed for longer life and reduced maintenance. Molded nylon, for longer wear and lubrication-free operation, is used for gear train gears, pinions and shafts. Contact block assemblies are molded instead of fabricated to raise the insulation level and make adjustment of contact blade pressures and gaps easier, according to manufacturer. Contacts, also larger, are said to provide longer life.

For ease of timing motor inspection, motor shaft extends through nameplate and is clearly marked. Marker arrow has been added to allow checking of motor synchronism. One model has current rating of 35 amps allowing application to high wattage water heaters.

General Electric, Meter Dept
Somersworth, N. H.

For more details on these items, use post cards p 161. Identify your request with item number.



Sealed-register water meter

721 • Water meter utilizes magnetic force to transmit motion from the measuring chamber to a hermetically sealed register. Unit contains no stuffing box or separate

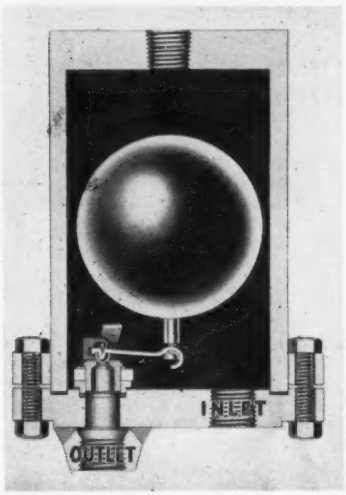
More EQUIPMENT NEWS

Begins on page 152

intermediate gear train. Contains 15 stock parts of which only two moving parts operate in contact with water.

Replacing the separate gear train and stuffing box in meter are two permanent magnets. One is contained in the oscillating piston in the measuring chamber; other travels in a well in the sealed register. Force between them effectively transmits motion from measuring chamber to register. Details from manufacturer.

Rockwell Mfg Co
411 N Lexington Ave, Pittsburgh, Pa.



Dual gravity traps

733 • Units are designed for interface service to discharge water or heavy liquids and close for light liquids. Discharge valve is actuated by a stainless steel ball float, weighted to sink in the light liquid and float in the heavy.

Units are produced in two series: semi-steel for low temperatures to 300 psi; and fabricated steel for low temperatures to 1000 psi. Typical installations include removal of water from gasoline accumulators, settling tanks, evaporators and pipe lines carrying light liquids with water present.

Clark Mfg Co, 1830 E
38th St, Cleveland 14, Ohio

For more details on these items, use post cards p 161. Identify your request with item number.

Air compressor

742 • This two-stage 200-psig-rated motorcompressor is available in 1½ and 2-hp sizes. The complete packaged unit includes the motorcompressor, cushioned rubber mounting on an ASME vertical tank, interconnecting piping and fittings and automatic start and stop control.

Manufacturer claims important safety and space-saving features in new unit. Hazardous belt drive is eliminated because the compressor is flange-mounted directly on the driving motor. Due to this direct

Every RIDGID Pipe Tool
TESTED
individually
before
shipment
Extra Fast...
...easy...pipe reaming
with this self-feeding
RIDGID
Spiral . . . turns into the work smoothly, no chatter. Famous RIDGID heat-treated cutting edges mean clean reaming, extra long service. Quick enlarging of conduit box outlets—and holes in sheet metal. More for your money—buy the 2-S at your Supply House.
for power
and hand reaming . . .
RIDGID
LonGrip
5 long straight flutes ream clean, easy to control.
RIDGID
Work-Saver Pipe Tools
The Ridge Tool Company • Elyria, Ohio • U.S.A.

Panalarm Annunciator pinpoints process "off-normals"

In the process industries and among users of automatic machinery, trouble is minimized when it's caught early. That's the purpose of the Panalarm Annunciator System—a continuous monitor of your process.

One typical adaptation of the modular Panalarm system is engineered to differentiate between the first "off-normal" and subsequent "off-normals" caused by the first. This feature allows instantaneous recognition of the prime source of trouble in a "chain reaction."

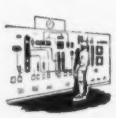
Another adaptation is designed specifically for motor start-up and shut-down. It has also been successfully adapted for supervisory control, pump control and programming.

Your Panalarm sales engineer will be happy to make a survey of your requirements to determine whether a Panalarm system can aid productivity and safety in your process. For electrical and mechanical data on standard systems, request Catalog 100B on your letterhead.

PANALARM

Division of
PANELLIT, INC.
7417 N. Hamlin Avenue, Skokie, Illinois
Panellit of Canada, Ltd., Toronto 14

Engineered Information Systems for Industry


Graphic Panels, Control Centers

Panalog Information Systems

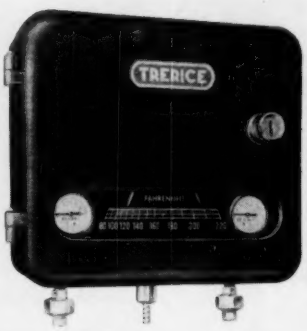
Panellit Service Corporation

More EQUIPMENT NEWS

Begins on page 152

mounting, unit is said to require less than half the floor space of tank-mounted, belt-driven units of comparable size. It can also be mounted on a shelf, side wall or overhead bracket with the air receiver located in an out-of-the-way space.

Ingersoll-Rand Co
11 Broadway, N. Y. 4, N. Y.



Air-operated controller

736 • Mercury-actuated indicating temperature controller is available in two basic types: (1) on-off fixed high sensitivity or (2) proportional band. Unit can be changed from direct to reverse acting or back without tools, according to manufacturer.

Specifications: Wall-mounted cast-aluminum case with bottom outlet. Standard ranges to 800 F and furnished with 5 ft heavy, flexible bronze connecting tubing, ¾ in. NPT chrome-plated union fittings, and stainless steel bulb for liquid immersion. Details from manufacturer.

H O Trerice Co, 1420 W Lafayette Blvd, Detroit 16, Mich.

For more details on these items, use post cards p 161. Identify your request with item number.

Diesel safety switch

734 • Temperature and pressure-sensitive switch is designed to warn of overheating diesel engines before internal damage results.

Switch is said to respond to abnormal temperatures (up to 250 F) or pressures (to 70 psi) to stop or idle the engine, or set off an alarm. Unit comprises two separate systems, one for temperature measurement, one for pressure measurement. Both are mounted on a common frame and enclosed in a metal case.

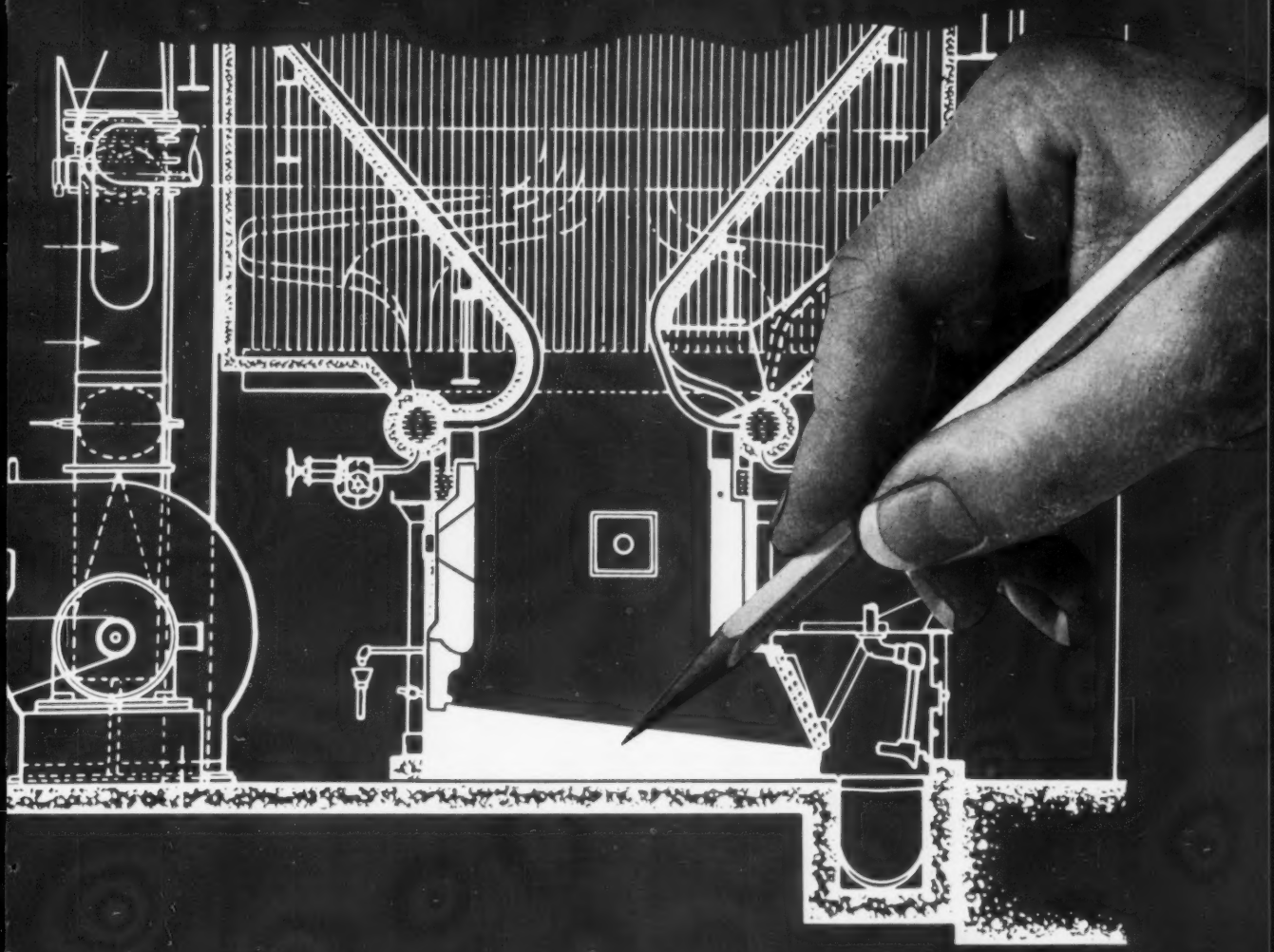
Minneapolis-Honeywell Regulator Co Industrial Div, Wayne & Windrim Aves, Philadelphia, Pa.

Electric chain hoist

743 • Lightweight unit is said to be adaptable for use on production lines, over machine tools, or in any shop location where space is at a premium.

Rugged, durable and light in weight for

How to draw the line on ashpit maintenance



"Let's put Kaocrete here"

Relining ashpits is expensive and time-consuming. That's why more and more utilities and industrial companies are specifying a heavy-duty refractory castable such as B&W Kaocrete D. On job after job, it has withstood the heavy abrasive or erosive attack of sprays, jets, rakes or shovels.

The reason? Specially designed Kaocrete D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It saves time because it can be poured or gunned into place. For less severe abrasive or erosive conditions, B&W recommends Kaocrete A.

Get the facts and figures on these B&W Refractory Castables from your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42ND ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

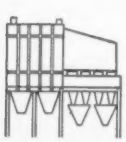
R-34b

How to tame a dust collection problem

Look for the 'hidden' factors that deliver important *extra efficiency*, like the exclusive Shave-off in Buell Cyclones that harnesses the double-eddy currents to trap an extra percentage of dust. Side-entry of gases, Buell-designed manifolds, proper proportioning, extra-heavy-plate construction provide even more efficiency. Send for the ready reference booklet, "The Collection and Recovery of Industrial Dusts". Dept. 50-G, Buell Engineering Company, Inc., 70 Pine Street, New York 5, N. Y.

BUELL CYCLONE

"SF" ELECTRIC PRECIPITATOR



PRECIPITATOR-CYCLONE COMBINATION

buell®

Experts at delivering Extra Efficiency in

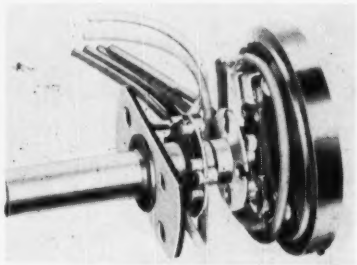
DUST COLLECTION SYSTEMS

More EQUIPMENT NEWS

Begins on page 152

ease of installation and ease in moving from job to job, it is available in two types of reeving: the 300-2000 lb capacity, single-chain unit and the 3000-4000 lb capacity, double-chain unit.

American Chain & Cable Co, Inc
929 Connecticut Ave
Bridgeport 2, Conn.



Speed detector

738 • Self-contained device can be flange mounted in any convenient location according to manufacturer. It is dust tight and provides its own shaft mounted in ball bearings. Shaft can be coupled by any normal method to shaft of the equipment to be protected or controlled.

According to manufacturer, new unit can incorporate almost any combination of sensing switches to detect overspeed and underspeed in a narrow or wide range. It is said that, once detected, the speed can be controlled by any practical circuitry.

Torq Engineered Products, Inc
32 W Monroe St, Bedford, Ohio

For more details on these items, use post cards p 161. Identify your request with item number.

Pocket slide calculator

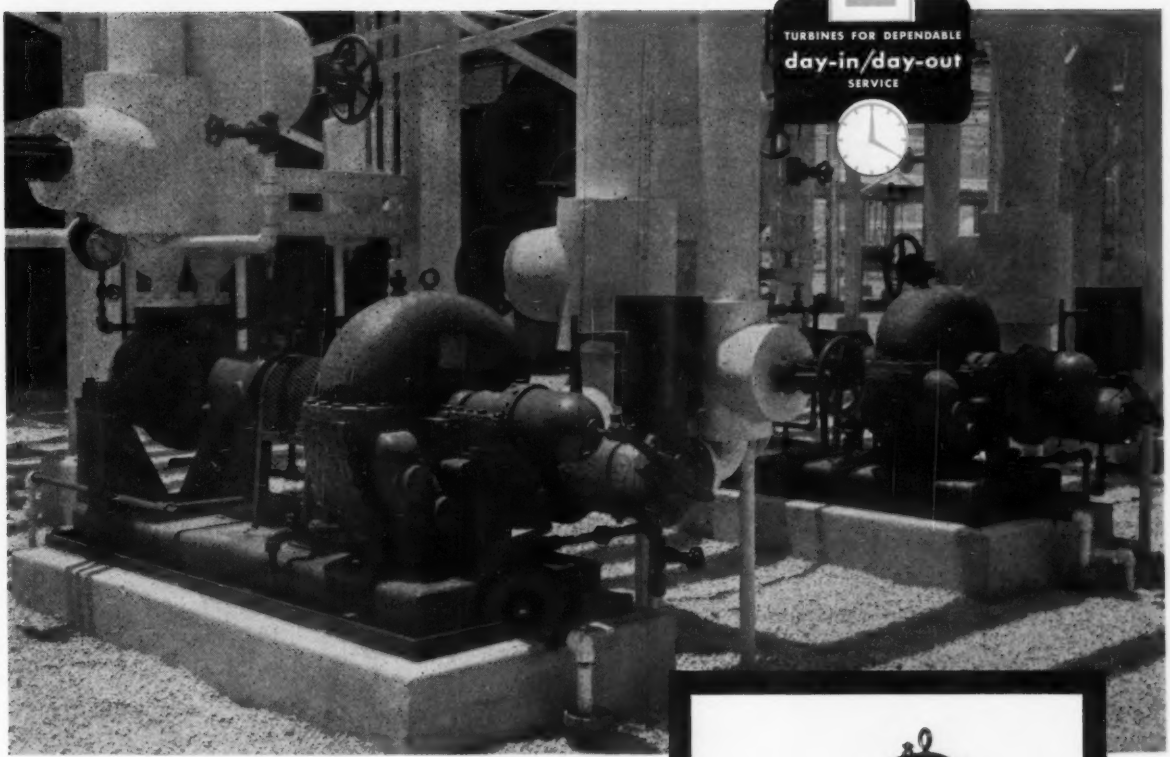
★ Calculator is used for figuring water pipe and paper stock pipe friction losses.

Data for computing water pipe friction loss are based on standards of the Hydraulic Institute and appear on one side of the calculator while those for determining paper stock pipe friction loss are on the other side. Measuring 9¼ by 4 in., this calculator also carries a table of equivalent lengths of new straight pipe for valves and fittings for turbulent flow. ★Request direct on company letterhead.

Allis-Chalmers Mfg Co
Milwaukee 1, Wis.

Variable delivery pump

729 • Unit develops 5700 psi and is intended for hydraulic power applications. According to manufacturer, oil delivery can be manually adjusted to any desired value (within available range) or can be left to vary automatically inversely with pressure changes. This feature is said to produce great savings in power, especially during holding stages of an operating cycle of presses of any kind, when only limited



ELLIOTT YR TURBINES

the best anywhere... serving process industries everywhere

There's no mystery behind the popularity of Elliott YR turbines. They are deliberately designed to provide the highest quality, long-term continuous service. Turbine components are made of the finest materials, built in quantity to close tolerances and rigid specifications. Assembly is carefully controlled to meet the required—and in fact the most rugged—operating conditions. Easy inspection, accessibility of wearing parts and interchangeable components are additional advantages.

That's why thousands of Elliott mechanical drive turbines are in use all over the country—like the two above, driving a natural gas plant pump in West Texas. For Bulletin H-22B which describes the designing features, call your local Elliott field engineer or write Elliott Company, Steam Turbine Division, Jeannette, Pa.

6 design features you get with ELLIOTT YR single-stage turbines

- True Centerline Support for precise alignment, cold or hot, simplifies installation.
- Weather-Proofed, Reliable Governing System with separate overspeed trip and valve.
- Liner Type Bearings, easy to inspect or replace, rapid heat transfer to cooling oil, sealed against elements.
- Accessible Shaft Seals. Covers—not part of turbine casing—are easily removed for inspection or ring replacement.
- Self-Locating Rotor drops into position without adjustments. Entire rotor is dynamically balanced.
- Interchangeable Components permit interchanging of parts between turbine frame sizes, eliminates need for large inventories.

H7-2

ELLIOTT Company

Steam Turbines • Motors • Generators • Deaerating Heaters • Ejectors • Condensers • Centrifugal Compressors • Turbochargers • Tube Cleaners • Strainers

CONSTRUCTION FEATURES ---

PLUS CONTROLLED QUALITY

make Your Choice of the

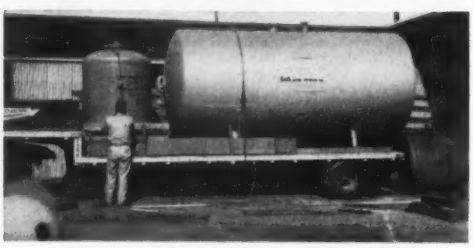
L★A Deaerator

a Wise One indeed!

- Always completely assembled in our own shop
- Always fabricated by our own skilled employees
- Constantly supervised by our own engineers
- Fabricated of highest quality materials
- API-ASME approved shop
- Always a final check-out of assembled unit
- One complete bulk shipment
- Jet atomizing tray and combinations available
- All stainless steel internals
- Self-adjusting to all loads
- 10,000 to 2,000,000 lbs. per hr. capacities

Automatic welding machine in L*A shop

From your initial inquiry through the shipment of the completed deaerator, L★A Water Softener Co. takes complete responsibility. You are assured of the finest workmanship and control with constant inspection and supervision by our qualified engineers as fabrication and assembly proceed. Consistant top quality equipment is the result.



100,000 lbs. per hr., 10 min. storage unit being loaded for delivery to eastern chemical manufacturer

You KNOW where your L★A Deaerator is made! And this complete control from one source enables L★A to deliver **on schedule** and ready for quick installation.

May we send you a copy of our new Deaerator booklet? Simply ask for Bulletin 102-A

L★A WATER SOFTENER COMPANY
1007 Air Way, Glendale 1, California
REPRESENTATIVES IN PRINCIPAL CITIES

Demineralizers • Hot Process Softeners • Floc Treators • Deaerators • Zeolite Softeners • Dealkalizers

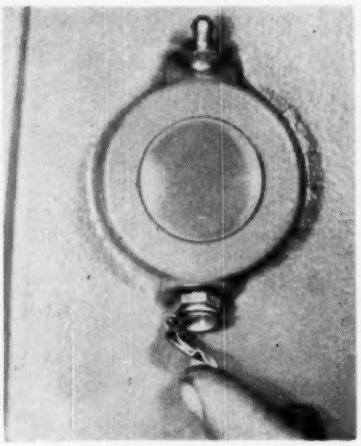
More EQUIPMENT NEWS

Begins on page 152

delivery is required to maintain the preset maximum pressure.

Manufacturer states that these pumps are also well suited for any operating cycle wherever substantially constant power is desirable during working periods. Sizes from 1½ to 30 hp are offered either as bare pumps or as package power units.

Equi-Flow Div, Vibro Mfg Co, Inc Woodside, N. Y.



Lubrication fitting

723 • Relief-type lubrication fitting is suited for use on antifriction bearings in motors, machinery, pillow blocks, or any ball or roller bearing housing equipped with conventional relief plugs.

Unit features a flip-open cap said to speed bearing lubrication. Body of the fitting is internally flared to allow free discharge of excess grease. According to manufacturer, unit does away with relief plugs which cause neglect and thus helps prevent over-lubrication and resultant contamination of windings.

Keystone Lubricating Co 3100 N 21st St, Philadelphia, Pa.

For more details on these items, use post cards p 161. Identify your request with item number.

Barometric pressure transducer

744 • Unit requires no electric equipment and its transfer functions can be made to match any design requirements. According to manufacturer, this ac transducer is completely passive and has a very low power consumption. Comparatively unaffected by temperature changes, unit has a range from sea level to 40,000 ft. Special units available to 60,000 ft.

Darco Industries, Inc, 2151 E Rosecrans Ave, El Segundo, Calif.

Compound fights corrosion

745 • This powdered-acid material is said to remove rust, scale and corrosion with greater safety to metal surfaces as well as personnel. Added to water in concentra-

Danger: Foaming Turbine!

Time for Cities Service Pacemaker-T Oil

No question about it—a foaming turbine lubricant means danger!

Foaming hampers hydraulic governors and other control mechanisms that depend on the non-compressibility of an oil for proper operation.

Generally, it's not the turbine but the lubricant itself that's to blame.

For only a lubricant with the finest anti-foam additives—a lubricant such as Cities Service Pacemaker-T—can withstand constant churning.

Equally important to flawless operation are the other qualities of Cities Service Pacemaker-T Oils: superior oxidation and rust resistance, excellent water separating qualities, and proper viscosity.

If you'd like a more efficient operation—or want to know what type of lubricant is best for you—call in a Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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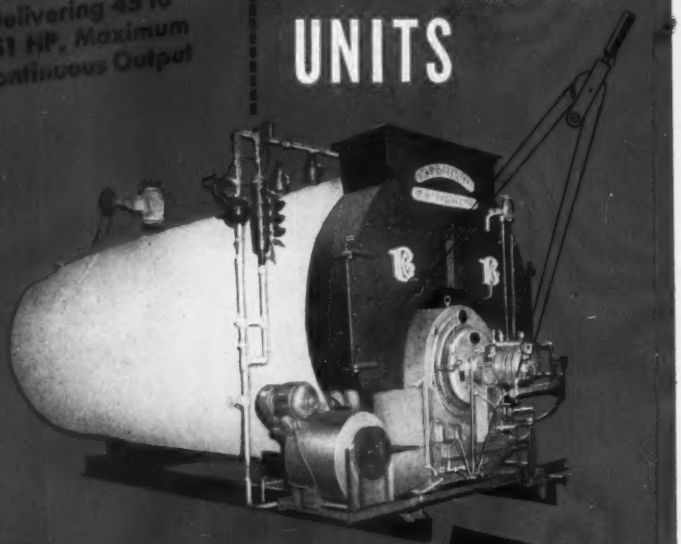
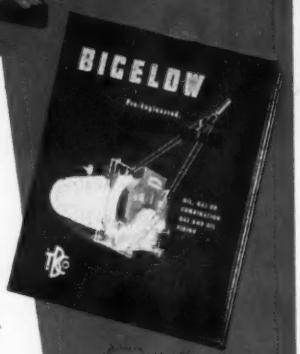
QUALITY PETROLEUM PRODUCTS

Self-Contained Steam Production to Fit Your Need

19 SIZES
30 to 434 HP, S.B.I. Rating Delivering 45 to 651 HP, Maximum Continuous Output

BIGELOW
BOILER-BURNER
UNITS





READY TO OPERATE AS SOON AS CONNECTED
Combines the boiler that closely fits your requirements with whatever top quality burner best suits your specific situation . . . Mounted on a steel base . . . Requires no special foundation, no high stack, no induced draft fan.

80% EFFICIENCY
Tubes correctly proportioned for efficient heat transfer promote 80% or greater efficiency.

RESERVE CAPACITY
8.2 square feet of heating surface per boiler horsepower, (STEEL BOILER INSTITUTE STANDARD) provides maximum continuous output reserve capacity 50% greater than nominal S.B.I. rating.

COMPLETELY AUTOMATIC — OIL, GAS OR COMBINATION GAS & OIL FIRING

Write For Your Copy Of This NEW BOILER-BURNER UNIT CATALOG

Catalogs also available on Bigelow Water Tube Boilers of various types.

THE BIGELOW COMPANY • NEW HAVEN 3, CONN.
Established 1833

Representatives: Boston • New York • Chicago • Orangeburg, S. C. • Philadelphia • Syracuse • Detroit • Washington, D. C. San Francisco • Los Angeles • Atlanta • Milwaukee • New Orleans Petersburg, Va. • Seattle • Indianapolis • Kansas City, Mo. • Tulsa Salisbury, Md. • Greensboro, N. C.

BI-17

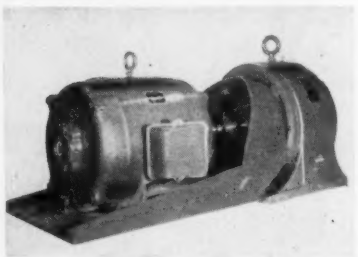
More EQUIPMENT NEWS

Begins on page 152

tions upwards of eight ounces to the gallon, *Drycid* is claimed by manufacturer to go into solution fast and to be useful in application by circulation or immersion. Solutions of the compound may be used cold or for faster action, heated to 165 F.

Major advantages claimed: ease in shipment and storage as it requires no returnable carboys; mild aromatic odor and nonfuming characteristic; greater safety on aluminum, brass and galvanized surfaces when used as recommended.

Oakite Products, Inc
123 Rector St, New York 6, N. Y.



Gearmotors

724 • Designed to meet user's specific needs, new gearmotors are available with polyphase, single phase and dc motors, with a variety of mounting positions possible, including downshaft and tilted shaft. They can be obtained in open drip-proof, dust-proof, explosion-proof and totally-enclosed frames.

Century Electric Co
1806 Pine St, St. Louis 3, Mo.

For more details on these items, use post cards p 161. Identify your request with item number.

Air filter

732 • Fully automatic filter measures ½ in. It is said to prevent moisture, sludge and other foreign substances heavier than air from entering air operated devices thus preventing deterioration of vital parts.

Unit operates on a maximum of 90 CFM. Maximum working pressure is 300 lb. Internal parts have been irradiated to pass a 100 hour salt spray test. Unit has been designed to filter air for pneumatic equipment operating on intermittent air flow.

Emco Pneumatic Corp,
1317 Locust St, Des Moines, Iowa

Power take-off

726 • Air-operated, remote-controlled friction power take-off is suited for use with engines up to 600 hp output in any industrial application where a standard power take-off is used, says manufacturer.

Engagement and disengagement of unit is accomplished by turn of an air valve.

Rotary seal has been added to the end of the output shaft to permit actuating air to enter clutch through a drilled passage.

Twin Disc Clutch Co
1361 Racine St, Racine, Wis.

Organic Chemicals Division
MONSANTO CHEMICAL COMPANY
Dept. PAC-74,
800 N. 12th Blvd., St. Louis 1, Mo.

Please send me Monsanto's bulletin on Pydraul AC telling how to minimize (1) air compressor explosions and receiver fires (2) compressor maintenance due to deposits on exhaust valves and air system components.

*NAME*_____

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Want to reduce fire hazard in your air compressors?...Read Monsanto's bulletin on Pydraul AC

When flammable oil mists and films gather in your compressed air system . . . you have a real fire risk!

Ease your mind—there's a new, fire-resistant lubricant to protect your equipment, your workers and your production flow from compressor fires and explosions caused by flammable oils. Simply replace your ordinary petroleum oils with fire-resistant Pydraul AC compressor lubricant.

Pydraul AC is chemically made, not a water-soap base mixture, not a petroleum oil. It's a completely new type of bearing-protecting lubricant. Pydraul AC is created especially for air compressors. With Pydraul AC lubrication you ease your mind about compressor fires and explosions. You may also reduce maintenance costs because Pydraul AC can minimize carbon deposits on air compressor exhaust valves and air piping systems.

There's no conversion problem—just drain out the flammable lubricant and replace with fire-resistant Pydraul AC—it's that easy!

For more facts—fast: Just mail the coupon today for the new Monsanto bulletin on Pydraul AC. No cost to you. It shows properties, field experience, operating economies, etc. Act *now.* Mail coupon *today!*

There's also a fire-resistant Pydraul for every industrial hydraulic job:

- General-purpose Pydraul F-9
- Pydraul 150 and Pydraul 60 for precision equipment
- Pydraul 600 for heavy equipment

PYDRAUL: Reg. U. S. Pat. Off.

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Organic Chemicals Division
Dept. PAC-74, 800 N. 12th Blvd., St. Louis 1, Mo.

MONSANTO®

Where Creative Chemistry Works Wonders For You

RAMBLINGS ON INSTRUMENTATION

The Low-Down on Boiler Plant Control Systems

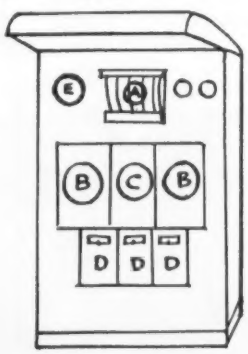
As you may or may not know, our company is up to its fetlocks in boiler plant instrumentation. We design instruments and controls, manufacture them, fuss over them, argue about them, even sit up all night with them on rare occasions. We've been at it for twenty years or so, in which time we've sold hundreds of systems.

And we're rather proud of the fact that, by and large, our systems have done what they are supposed to do, extremely well . . . making tight-lipped treasurers chuckle over lowered costs . . . causing dignified presidents to break out in gleeful buck-and-wings over increased efficiency . . . enabling harried engineers to enjoy carefree off-duty romps, untroubled by maintenance worries. In fact, the only people our systems seem to make unhappy are fuel salesmen who lack the broad viewpoint.

As red-blooded American businessmen, we'd like to sell more of these systems . . . particularly to you. We think a good way to go about this might be to widen the understanding of just what a system does.

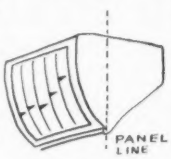
Let's start with a look at the control panel, a hunk of ¼" steel perforated like a Swiss cheese with holes for instruments.

The sketch below positions the instruments most generally found on any panel. To wit: (A) draft gauges, (B) flow meters, (C) some type of combustion guide, (D) an integrated group of controllers and (E) pressure gauges.



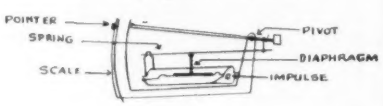
Boiler plant engineers being the independent cusses they are, you seldom see two panels exactly alike. But the basic jobs of all the gadgets on any panel is simply (1) to provide information and (2) to automatically control variables.

Let's take a look at one of the fundamental "information-providers" on the panel—(A) the Draft Gauge. This is the sensitive stethoscope of the power plant engineer. With it, he can observe variations in gas or air pressures and draft. To his experienced eye, every variation has its meaning. Is there proper flow of air into the boiler? Is soot building up in the boiler tubes? Is the condition of the fire bed satisfactory? Has a fan conked out?



To save panel space and facilitate "human scanning" for trend information, boiler plant draft gauges are usually banked in series from 2 to as many as 24.

Most of them utilize a slack leather diaphragm—first used by Hays and widely adopted by others (who shall remain nameless). They operate like this:



Hays has a special model, the "W" Gauge, engineered just for the boiler plant. We're biased, but we think it has some really fine features, such as:

readability—can be read at 25-30 ft.
accuracy—2% of scale
appearance—smart, aluminum case
overpressure—100% of range
zero adjust—front or bottom

Our spec sheet 56-1180-31 is loaded with data on this instrument. Why not send for it? Next month: "Flow Meters."

Phil Sprague Jr.
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

MARMADUKE

Continued from page 140

Jasper Oglethorp visited my boiler and engine room several times on that trip. He asked a slew of questions.

"One evening, while drinking mint juleps, he opened up and told me his problem. He had built a new plant the year before with local help. His brick boiler house in back of the new plant had three Heine cross-drum boilers.

"Oglethorp told me that the boiler and engine room equipment was second hand, but in good condition. Trouble started with the new plant soon as it was lit off. The boilers belched thick black smoke, especially at peak loads. Smoke had become so bad that people living nearby were almost blacked out at times. And the smoke was much worse in winter than in summer.

" 'Why don't you make your consulting engineer find the trouble?' I asked.

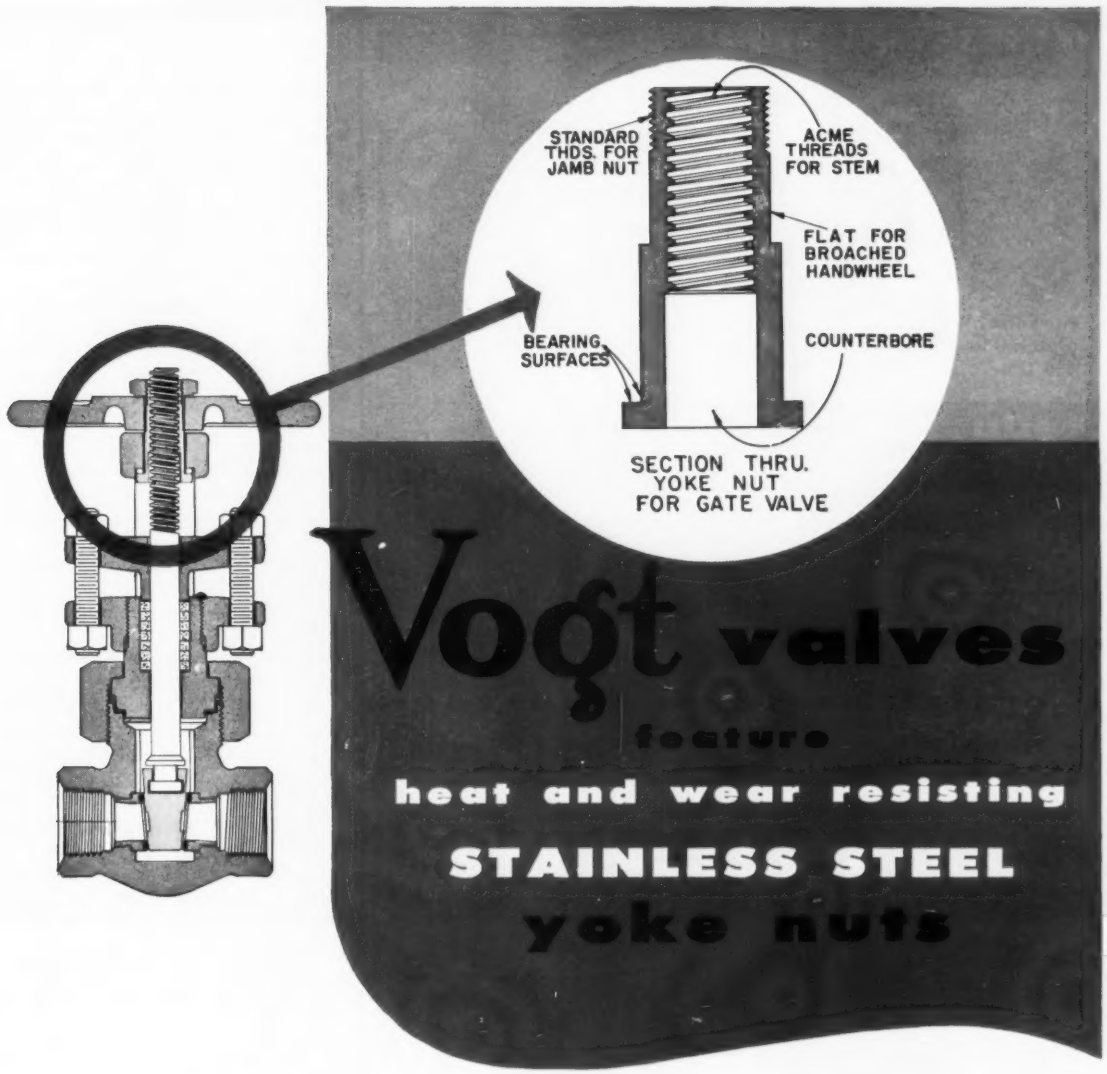
" 'Because my chief engineer planned and erected everything, with local help,' he answered. 'He set up the machinery and the boilers and did all the steam fitting,' explained Oglethorp. 'That guy's so good he can do anything. And the old boy didn't even get out of the second grade in school. Does everything by ear, yes sir,' he bragged, 'but that smoke has got him stopped and I gotta do something about it.'

" 'Then why don't you get a consultant from St. Louis or Memphis,' I asked. 'He could visit your plant and tell you the trouble in a hurry, if he is any good.'

" 'You don't know how those fancy consultants are,' moaned the merchant. 'They spend a few hours in your plant looking wise, then go back to their office and send you all kinds of fancy recommendations. To follow their advice you have to spend a young fortune. I wouldn't mind if they did something for their money, but all they do is make suggestions. Then you still have to shell out to have the trouble corrected,' he wailed. 'Now I wouldn't mind paying one of those smart alecs if he rolled up his sleeves and went to work and maybe sweated a little for his money. But none of them are going to take a highfalutin all-expense vacation on my bankroll. No sir!'

"That song and dance gave me the low-down on my friend. He was a tightwad who expected blood for his money. But in those days a lot of big shots took a dim view of consultants. Oglethorp raved on, studying my face to see how far he could go. Then he suddenly threw his Sunday punch.

" 'How about a visit to my plant when we reach Cairo tomorrow?' he asked. 'The ride will do you good and I'll show you how we process food. Then maybe you can drop into the



Heat and wear-resisting *stainless steel* yoke nuts in Vogt Valves give longer trouble-free service. We have proved this in our own "Torture Chamber," under constant and accelerated testing, as well as in tough service applications. They are made from a special stainless steel alloy having excellent bearing quality, matchless strength, and a melting point of approximately 2700°F.

The rotating gate valve yoke nut design, illustrated, has flats for a tight fit with the square broached hole of the handwheel. Non-rotating yoke nuts, for globe and angle valves, are of the same superior design and quality. Vogt GP Valves are available in a complete range of sizes from 1/4" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Adv. No. 6 in a series describing the features of Vogt GP Valves.

Write For Your FREE COPY of Supplement No. 1 to Catalog F-9. Address Dept. 24A-FP.

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P. O. Box 1918—Louisville 1, Ky.

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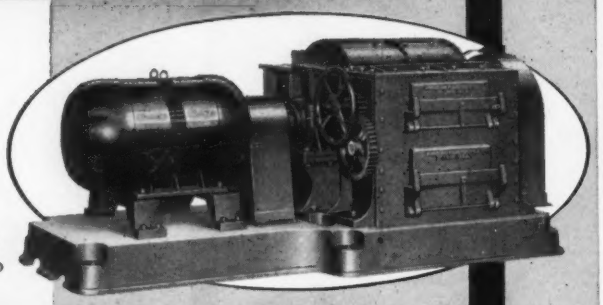
Vogt GENERAL GP PURPOSE Vogt FOR BETTER VALVES

DROP FORGED STEEL

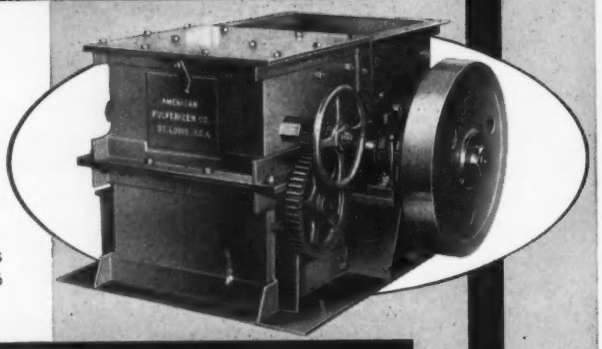
VALVES

When You Figure . . .



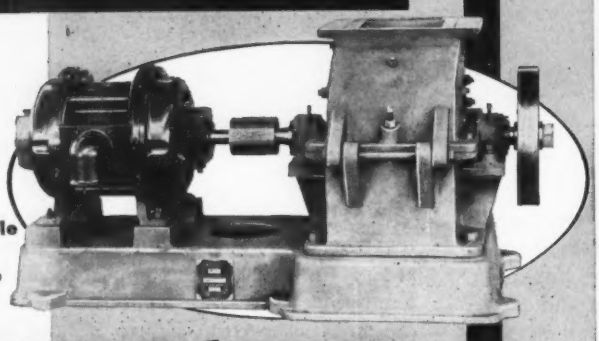
AC Series
capacities to
800 TPH

Reduction
Cost Per Ton . . .



WC Series
capacities to
90 TPH

the Best Answers*. . .



Coal Sample Crushers
capacities to
2000 Lbs.
Per Hr.

Come from *American*
Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of *less than 1/10th of 1¢ per ton.*

THERE CAN BE NO BETTER PROOF OF AMERICAN QUALITY!

WRITE for Literature on These Crushers

American
PULVERIZER COMPANY
Designers and Manufacturers of Ring Crushers and Pulverizers
1349 MACKLIND AVE. • ST. LOUIS 10, MO.

MARMADUKE

Continued from page 180

boiler room and give our chief a few pointers. I notice this packet smokes less than any boat I've been on. Suppose I pick you up at the levee when we tie up. I'll bring you back to your boat. Maybe our shipping department can fix you up with a prime case of canned peaches — if you find our trouble,' he added cautiously.

"'That's mighty generous of you to offer me that present,' I answered, trying not to blow a gasket. 'But I wonder if you know the smoke you're sending into the atmosphere is unburned fuel. It's not only a nuisance to your neighbors, but it's costing you bales of money besides. Now I'm not sure if I can put my finger on the trouble in one short visit. But if I can, it won't be for a case of peaches.'

"'Well now,' he said, getting up a little steam. 'I think that's a reasonable gift for a pleasant visit out into the country.'

"'Suppose you keep your peaches and plunk one-hundred iron men on the barrel head if I stop that smoke,' I stated, cutting into his conversation.

"'W-H-A-T?' he wailed, getting pink around the gills. 'One-hundred dollars just to tell me what's wrong?' Before he could say more, I got up and started to walk away.

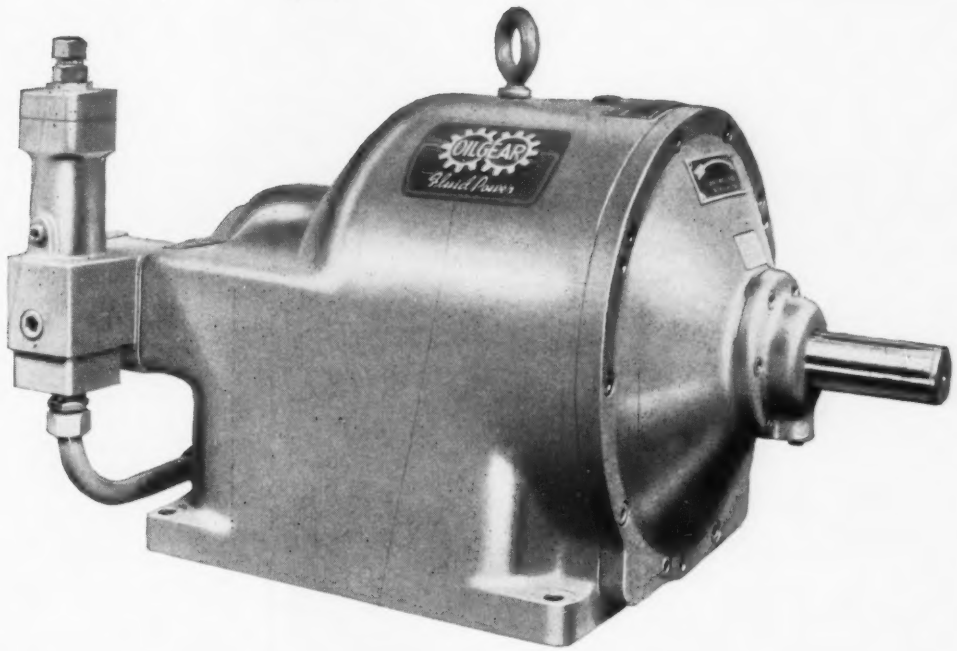
"'Just a minute, Mr Surfaceblow,' he called after me. 'How much time do you expect to spend at my plant for that kind of money?'

"'Maybe one minute, maybe one hour, maybe one day, I don't know. I'm not selling you time, I'm selling you results. Isn't that what you want?'

"While he sat there sweating about parting with his cash, I went below.

"Next morning we tied up to the Ohio Levee at the foot of 24th Street. After starting my gang on their day's work, I headed ashore to visit with my friend Cornelius Molloy, proprietor of the White Hall Saloon. But there was Oglethorp, sitting in his carriage near the gangplank. He said he decided to pay me that money after all—but only if I could make the repairs needed without costing him additional money. I agreed. I got into his carriage and we drove alongside the Illinois Central tracks towards Mound City. His plant was only 15 minutes away.

"My food-merchant friend didn't have to point out his plant. I could see smoke belching into the sky a mile before we got there. Looked like a Ringelmann No. 8. After bouncing along the dusty road we finally pulled up to his new boiler house, built of old brick. It had four windows at one end. Three were very small, the other very



OILGEAR CONSTANT AND VARIABLE DELIVERY PUMPS. Sturdy, compact units built in sizes having normal ratings from 4 to 150 hp. For over 5 years, Cellulubes kept the durability of these pumps high, even on constant pressure applications.

Where a fire-resistant lubricant is a must—

Celanese Cellulubes give you the plus feature of excellent lubrication . . .

More and more equipment manufacturers and lubrication engineers are learning that fire-resistant Cellulube lubricants provide superior protection against excessive wear during continuous operation under extreme pressures. Tests conducted by The Oilgear Company of Milwaukee, Wisconsin on various fire-resistant fluids showed that Cellulubes "seem to be the most satisfactory fluids for use in Oilgear pumping equipment."

Cellulubes are straight phosphate ester base synthetic oils . . . chemical compounds that contain no additives. Because of this, and because of lower flammability and reduced tendency to form undesirable deposits, Cellulubes can provide excellent lubrication combined with dependable fire protection.

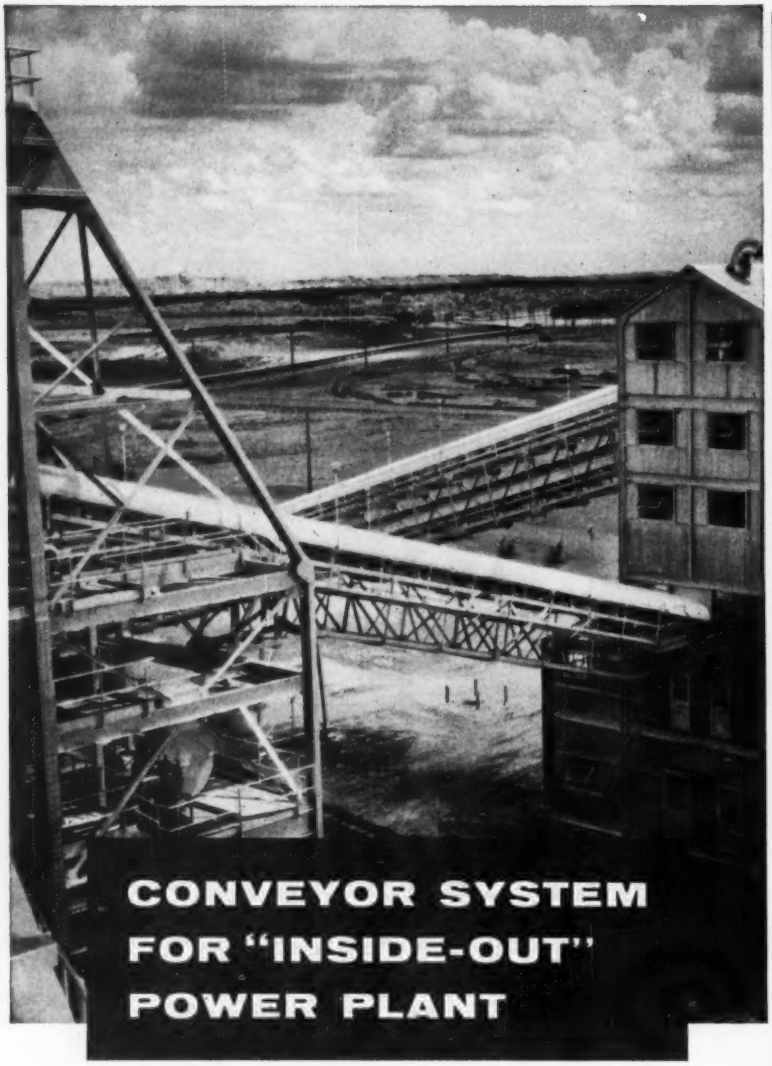
Cellulubes are available for supply in 6 controlled viscosities to meet exacting requirements in the replacement of flammable lubricants presently in use in your plant or equipment. Write for working samples and complete data for a thorough evaluation.

Celanese Corporation of America, Chemical Division, Dept.597-G, 180 Madison Avenue, New York 16, N. Y.

Celanese® Cellulube®

Celanese CHEMICALS

In Canada: Canadian Chemical Co., Limited, 2035 Guy Street, Montreal, P. Q., Canada
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.



Lignite weighing 45 pounds per cubic foot, maximum lump size 6", is crushed, stored, reclaimed, and delivered to silos over a Hewitt-Robins conveyor system in Aluminum Company of America's Rockdale plant, engineered and constructed by Ebasco Services, Inc. To prevent accumulation of explosive lignite dust, all conveyors are sheathed with aluminum and structural members of the buildings are on the *outside*, rather than the inside.

The entire system, including 14 conveyors, 10 belt feeders, 2 Vibrex screens, and other equipment, was designed, manufactured, and installed by Hewitt-Robins. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

HR HEWITT-ROBINS

CONVEYOR BELTING AND IDLERS...POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE...VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

MARMADUKE

Continued from page 182

large, probably out of an old store front. The weather was chilly and I noticed the windows couldn't be opened.

"I opened the door to the boiler house. As Oglethorp walked inside, I stepped back and squinted up at the stack. Then, seeing what I was looking for, I walked slowly inside but didn't close the door.

" 'Close that damn door, yahear?' yelled an angry voice from somewhere inside. I closed the door.

" 'Sorry Mr Oglethorp, I didn't know it was you,' apologized an old red-faced man, coming around the end of a boiler. 'It's hard enough keeping steam up on these boilers without letting all the cold air in here to cool down my fire beds,' he apologized.

" 'Shake hands with Mr Surfaceblow, chief engineer of the *Susan Greene*,' cut in the food merchant. 'I asked him to see if he can stop that smoke problem you've had right along. I suspect he'll be here for a spell. So I wish you'd answer all his questions.' Turning to me he asked, 'Didn't Captain Brubaker say your packet's gonna be here a few days, Mr Surfaceblow? If so, I suspect you'll be around here most of the day and maybe tomorrow.'

" 'I'm going to be out of here in exactly one minute,' I said, walking over to the work bench and grabbing a large piece of gas pipe.

"The two men looked at each other with a dumb expression on their faces, then looked back at me, waiting for an explanation.

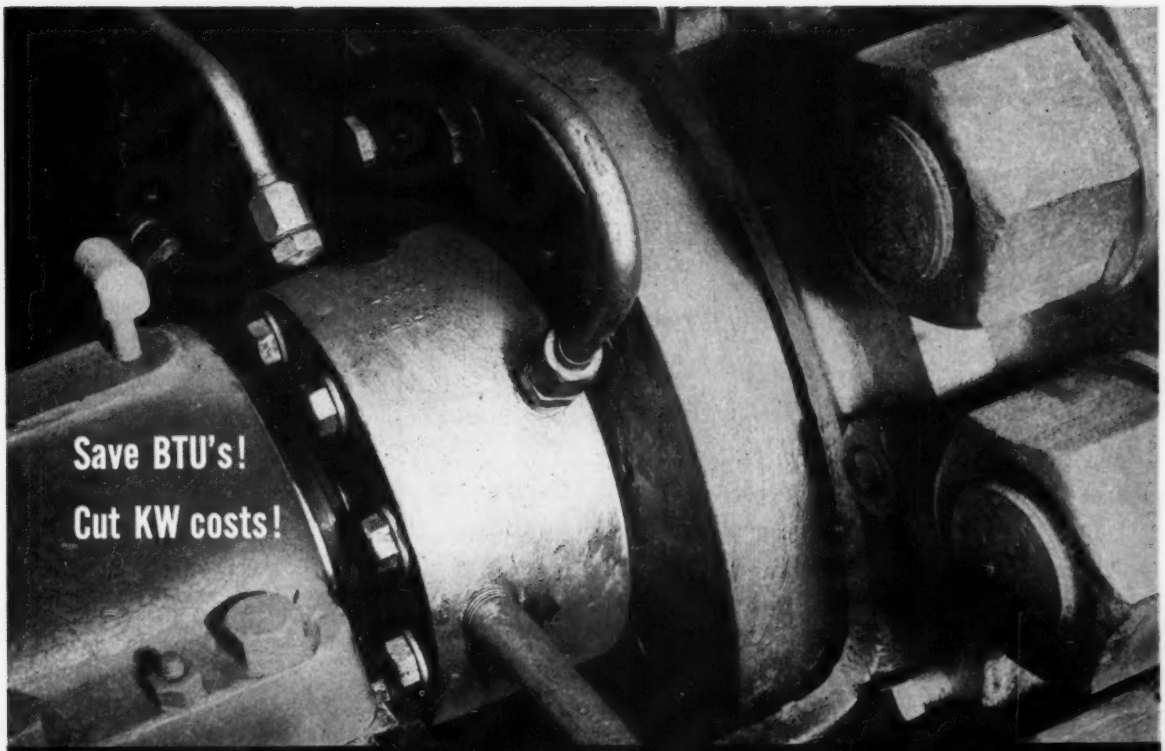
" 'Now this 2-in. diameter gas pipe is the answer to your problem,' I said calmy, holding it before them. 'It's about 3-ft long and made of wrought iron. It's just the right material and about the right weight. I'm using it because I agreed to stop the smoke before leaving your plant and not merely give you advice.

"The two men froze like statues, glueing their eyes onto that pipe. They were speechless and hadn't the foggiest notion of what I was driving at.

" 'It's not enough to be a good mechanic to run a power plant,' I continued. 'You have to do some reading and know your basics. Because I know my fuel-burning science, I'm going to make this pipe solve your problem right now.'

"With that I wound up like a baseball pitcher about to burn in a strike and heaved that gas pipe through the large window. The heavy plate glass splattered inward with one hell of a crash."

" 'What you doing'? yelled Oglethorp



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BENEFIT FROM THIS EXPERIENCE!

Lower cost per KW . . . that's the money-saving benefit of BJ Mechanical Seals for high pressure boiler feed pumps. These efficient seals save BTU's by minimizing feed water (and heat losses) along the shaft. Additional big savings are realized by eliminating costly repacking maintenance.

Byron Jackson pioneered the first successful seals for high pressure service . . . and continues to demonstrate this leadership with more installations for a constantly growing list of major power companies. Benefit from the experience of these and other companies . . . specify BJ Mechanical Seals *and save!*

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Belmont 754-P is a "custom-made" packing for centrifugal and rotary pumps, with a reputation as "nothing better for the service."

Lubrication is the secret of its performance. Lubrication that allows free shaft motion. Lubrication that is impregnated into every strand of asbestos yarn. Graphiting that is braided into this packing to stay, throughout its life.

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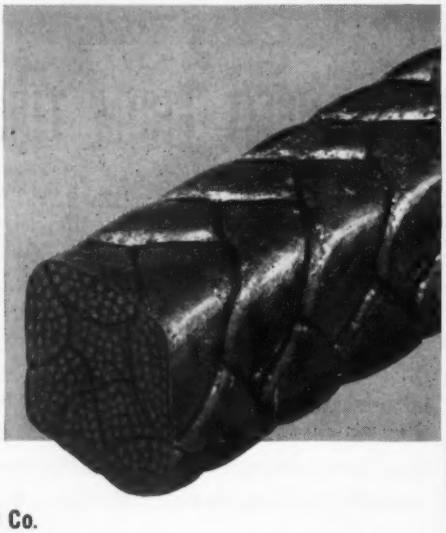


The Belmont Packing & Rubber Co.
Butler & Sepviva Sts., Phila. 37, Pa.

BELMONT

MARMADUKE

Continued from page 184

excitedly, turning white as chalk. 'You gone plumb crazy?'

"'Not crazy,' I answered calmly, just using my head. Your smoke problem is solved. If you don't believe it, step outside and look up at your stack. The chief here doesn't want the door left open, so my only remedy is an opening in the window until you can cut one in the wall or roof. Your boilers have been starving for air.

"While the two dumbfounded men looked at each other, then at the broken window and back at me,' I continued. 'When I opened the door it flew in so fast it almost pulled my arm off. But I knew your problem before opening the door because I heard air whistling in through the key hole. Now I'll thank you for that one-hundred clams and ask you to drive me back to town so I can finish my business with Cornelius Molloy.

"'One hundred dollars,' bellowed the food merchant, coming to life. 'Pay you one-hundred dollars for breaking my window?'

"'Not for breaking your window,' I corrected, "But for knowing which window to break."—STEVE ELONKA

Marmy's Mailbox

ARMCHAIR OPERATORS

The young operator in *Marmy goes to pot*, Feb 956, reminds me of an armchair operator we had. He did everything from his chair. For years he took only the second shift where few people were around. He even copied the temperatures from the log sheet instead of checking them. Marmy must have known him.

C G HOWARTER, *Canton, Ill.*

HORSE SENSE?

The Marmy episodes are uniformly good, interesting and in the main I like to think of them as 'horse sense in a light run.' For my money, his story, *Marmaduke, a philosopher?*, should be widely distributed in leaflet form. It carries a story with a moral; one that needs publicity to have it applied more widely in this day and age of ours.

E P MEIXSELL, *Catassauqua, Pa.*

WHERE WAS MARMY?

The Power Show at the new coliseum was the best yet. But I had one disappointment. Where was Marmaduke? Probably at the Bent Propeller Bar for a snort of Sandpaper Gin—or maybe a couple of gullet washers?

LT COMD'R R E MILLER,
River Edge, N. J.

No Excessive Heating

New Rectifier Cooling System Prevents Heat Build-up and Damage

when ac Power Fails

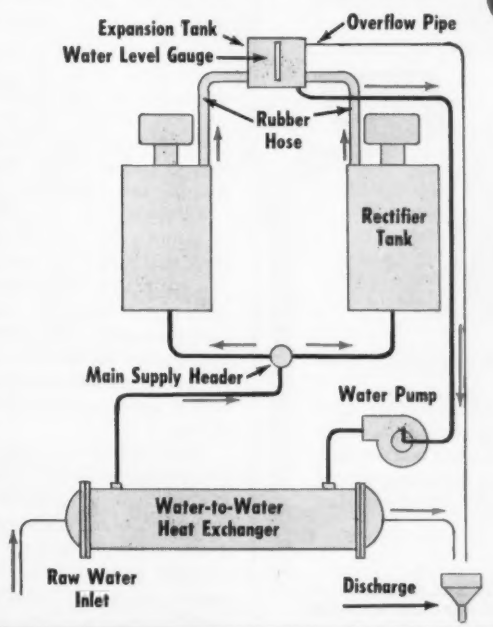
A SAFER, more effective cooling system in the Allis-Chalmers rectifier continues to circulate water *even when an ac power failure stops the water pump.* Heat and steam are dissipated before they can develop to the danger point.

The new system features an expansion tank that extends the full length of the rectifier frame with short vertical connections from each tube. With warm water continuing to flow freely upward, a thermo-siphoning action draws cooler water into the tubes. Build-up of excessive temperatures is prevented. Steam pockets are kept from forming. Subsequent water loss from the recirculating cooling system is minimized.

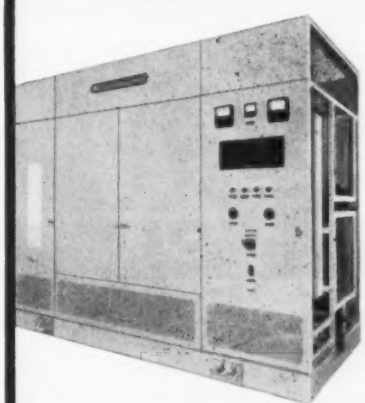
Successful operation in hundreds of installations is your assurance of the complete reliability of Allis-Chalmers mercury arc rectifiers. Contact your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

How the System Works

Water is normally pumped through the water-to-water heat exchanger to the main supply header from where it circulates through rectifier tubes picking up heat. Hot water flows up through the short connections to expansion tank and back down to suction side of water pump.



ALLIS-CHALMERS
Mercury Arc Rectifiers



Factory-packaged units cut installation time and costs. Sealed tube rectifiers are supplied in completely enclosed or open types. Here is a typical, completely enclosed, 1000-kw, 250-volt rectifier for steel mill service.

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A-C ALLIS-CHALMERS

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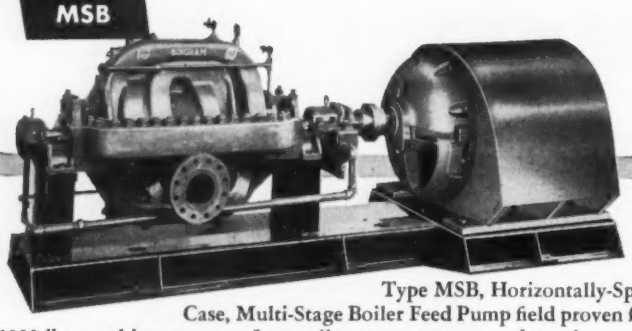
"DOUBLE VOLUTE"
BOILER FEED PUMPS

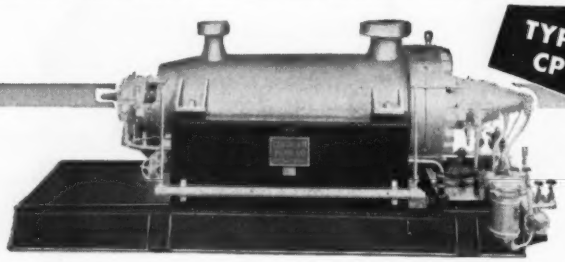
for the ultimate in dependability
IN HIGH PRESSURE SERVICE

TYPE MSB



Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP



Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

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FUEL ENGINEER

Continued from page 80

ation path, a fuel engineer rounds out a complete plant operating survey. Example: Assume three identical plants, one using bituminous coal, another No. 6 fuel oil, and the third natural gas. On each plant, the fuel engineer runs an operating survey, comes up with a data sheet, p 79, listing fuel analyses, average observations, heat balances and calculations in each case. Lb of steam produced per lb of coal, per gal fuel oil and per thousand cu ft gas are converted into cost per thousand lb of steam by applying a unit price for each fuel. (Assume delivery to points on the Eastern seaboard.) This shows:

Coal	*Oil*	*Gas*
Lb steam per fuel unit		
10.89	117.3	769.8
Delivered fuel price		
$10.00/ton	$3.50/bbl	$0.75/Mcf
Cost per M-lb steam		
$.46	$0.71	$0.974

or, in round numbers, $0.50, $0.75 and $1.00 per thousand lb of steam based on fuel cost only.

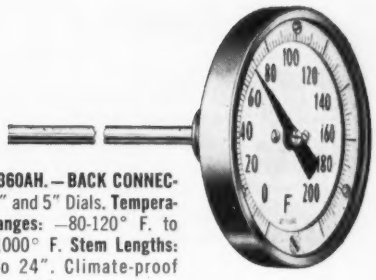
Survey's basic purpose is to dig out the facts that'll show just what will help and what will hinder both economy and facility of operation. It's especially important to plant management wrestling with the problem of striking a favorable balance between what the plant must have and what it can get from an economically available fuel.

Necessary data are those covering steam output, fuel-air ratios, various air and flue-gas temperatures — also types, physical dimensions and capacities of boilers, combustion equipment, controls and auxiliaries.

Results of our hypothetical surveys, as shown above, indicate that a change from coal to another fuel would be economically unsound, even though some surface factors might make a change seem favorable. Conversely, a survey could prove the need for changes either in fuels or firing equipment, despite a lack of apparent adverse operating conditions.

Since cost of fuel energy is the steam plant's largest single operating expense, it's the item of greatest potential influence in overall economy. A fuel engineer's plant-operating survey serves to (1) produce maximum economy under existing conditions without spending a lot of money (2) see if further improvements can be justified and (3) show whether savings indicate a conversion to some other fuel.

Top economy of an existing plant hinges on finding the lowest fuel cost, on an energy basis, which it *can* accommodate. Maximum economy of a new



TYPE 6360AH. — BACK CONNECTION. 3" and 5" Dials. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 2½" to 24". Climate-proof stainless steel case.

GET ACCURATE "ON-THE-SPOT" TEMPERATURE READINGS . . .

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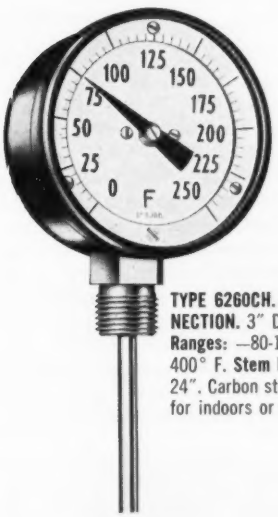
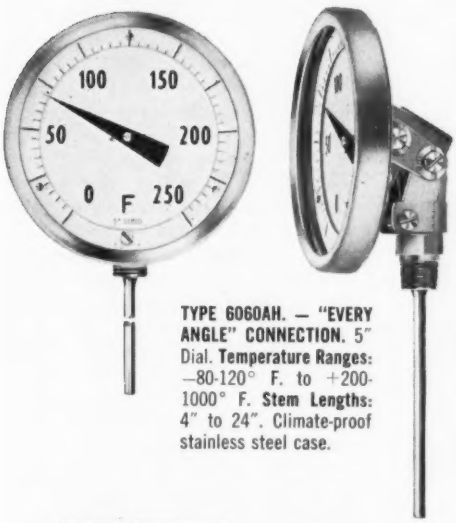
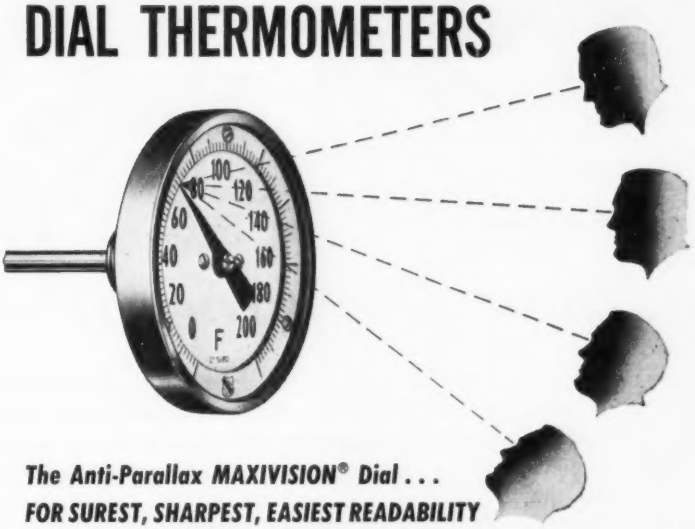


TYPE 6260CH. — BOTTOM CONNECTION. 3" Dial. **Temperature Ranges:** —80-120° F. to +50-400° F. **Stem Lengths:** 2½" to 24". Carbon steel case suitable for indoors or outdoors.



TYPE 6060AH. — "EVERY ANGLE" CONNECTION. 5" Dial. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.



The Anti-Parallax MAXIVISION® Dial . . .
FOR SUREST, SHARPEST, EASIEST READABILITY
. . . Is Available Only In 'American' Thermometers

Nowadays fewer men are required in power and processing plants to inspect operations, so it is more important than ever to have observation points handy for them. 'American' Bi-Metal Dial Thermometers, installed at important check points, eliminate frequent trips to the control house. Inspectors can observe variations in process temperatures "on the spot" and take steps to effect corrections.

The economy of these thermometers goes far beyond the time-saving convenience of local indoor and outdoor readings. Their accuracy and utility contribute to lower costs. They provide the greatest sensitivity in bi-metal actuation. The low-mass single helix bi-metal coil is precisely centered in the stem to assure quick, accurate response to all temperature changes — to prevent the retard effect the coil can cause if rubbed against the stem wall.

The Maxivision dial is a split-level dial with pointer set on the same plane as the outside raised ring that carries the graduations. No perspective effect, no parallax! Readings are sure, sharp and accurate at a glance!

The availability of 'American' Bi-Metal Dial Thermometers in types with back, bottom or "Every Angle" connection permits selection to fit the conditions of each location. For example, the "Every Angle" type can be set at any point within 180° on two axes. Thus it is particularly recommended for installation above or below eye level or in close quarters where the types with fixed back or bottom connection would be impractical.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for assistance in selecting the types of 'American' Bi-Metal Dial Thermometer best suited to your needs. He can provide separable sockets in all materials and sizes normally required.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

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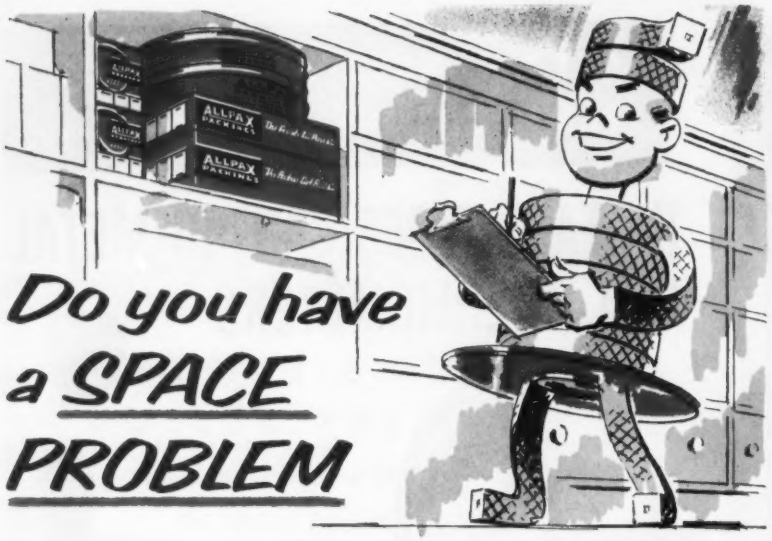

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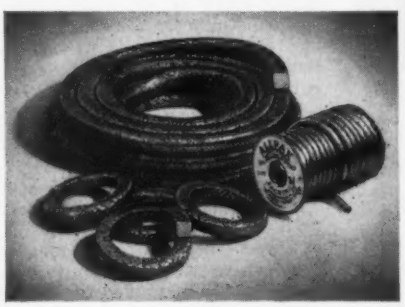

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FUEL ENGINEER

Continued from page 188

plant, however, depends on equipment choice that *will* handle fuels whose characteristics offer the greatest promise of low-cost operation. Wrong choice, regardless of reason for it, can make a plant pay through the nose for its energy requirements during its life.

BASICS

Continued from page 138

tem is referred to as a "phase" of the 3-phase system, as e_1 might be called "phase *a-b*." To add to the confusion, the three conductors of the system are often called "phase conductors" or "phase wires," and may be labeled "phase *a*, phase *b*, phase *c*." It's a common error to confuse *phase voltage* with *phase conductor*, and suppose that by disconnecting one phase conductor (let's say phase conductor *c*) you disconnect one phase voltage and leave a 2-phase system. Actually, disconnecting phase conductor *c* disconnects two phase voltages ($e_2 = b - c$ and $e_3 = c - a$), leaving only $e_1 = a - b$.

Current produced by a voltage wave can also be represented by a curve. If impedance of the circuit consists only of resistance, the current will be in phase with the voltage. If the impedance is wholly inductive reactance, the current will be 90 deg out of phase *lagging*. Current in an inductive circuit *lags* the voltage that produces it; that is, points on the current curve occur later than on the voltage curve. Current i_L in sketch *C* represents current produced by *e* in a wholly inductive circuit. Note that i_L begins to increase in a positive direction 90 deg or 1/240 sec later than *e*. Thus i_L is zero when *e* is maximum and i_L is maximum when *e* is zero. This occurs because inductive reactance is a counter-emf proportional to the rate of change of the magnetic flux. The flux is changing fastest when the current is zero. (Remember, when discussing current and voltage waves we're talking about *instantaneous* values, not the effective values which we measure on instruments and use in practical calculations.) In a circuit having resistance as well as inductive reactance, the current will lag the voltage by an angle less than 90 deg.

In capacitive circuits the current *leads* the voltage producing it. Here current is maximum 90 deg earlier than the voltage, as shown by i_0 in sketch *D*. Again, if the circuit has resistance, the angle of phase difference (displacement) is less than 90 deg.

Next month's Basics: *Voltage, current and power in ac circuits.*

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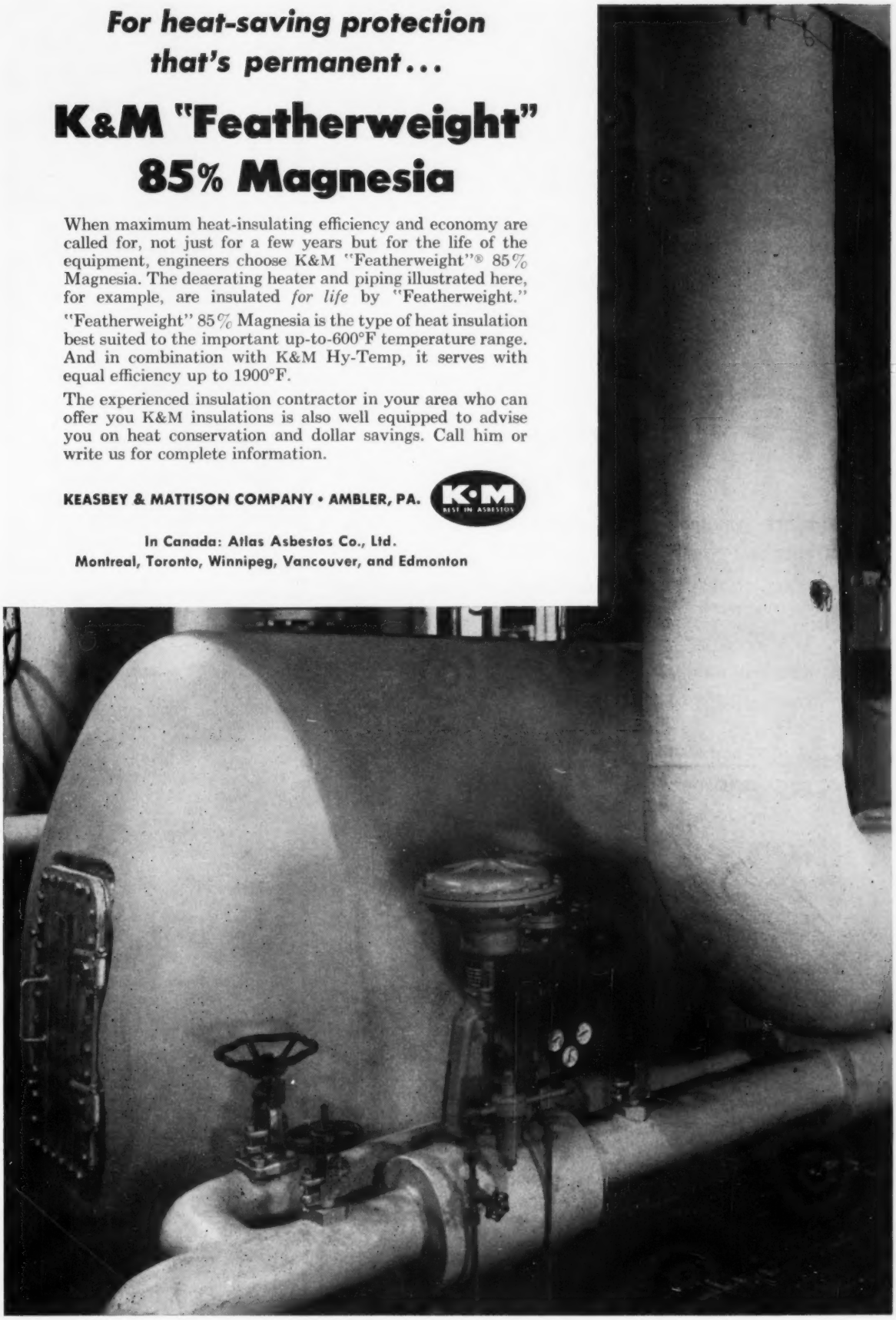

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1. **SCALE, CORROSION, or FOAMING** *in your boiler operation.*
2. **RUST and CORROSION** *in your steam and condensate lines.*
3. * **SCALE, CORROSION, or ALGAE GROWTH** *in your cooling or condenser water system.*
4. **CORROSION or SCALE** *in your hot or cold water tank and lines.*
5. **RUST and CORROSION** *in your brine or sweet water system.*
6. **SCALE** *in pumps, water jackets, compressors, coils, lines, or equipment.*
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My biggest boner

Years ago, when I was young and knew everything, I worked in the powerhouse of a good-sized lithographic concern. In those days the presses and other machines needed almost constant speed change. For that reason our generated electricity was all dc.

We had three generators, each direct connected to a big uniflow engine. It was a cantankerous corliss, liable to take off into the wild blue yonder when your back was turned. We also had a slide-valve engine.

One afternoon, the moving contacts of a large air circuit breaker needed changing. After assuring the chief that I had worked on them and knew just what to do, he gave me the job.

That evening, after things quieted down, I mounted my stepladder and stripped off the old contacts. Everything went well as I bolted up the new carbon arc breakers and slid the heavy laminated-copper main contact into place. Then I started to pull the bolts hand tight.

Just as I reached my wrench into these cramped quarters, I accidentally touched the stationary contact —WHOOM! The world blew up in my face—into a great yellow ball of fire.

A moment later I picked myself off the floor. Luckily I had nothing worse than a goose egg on my head and a large blister on my hand. The wrench was almost burned into two pieces.

A sadder and wiser guy, I found a rubber blanket to cover the live contacts. Happily, the contact faces were undamaged and I was able to finish the job. My boner lay in the assumption that conditions were the same as when I had worked on other breakers. Previously we had changed them on a weekend with all equipment shut down. I had forgotten that I had an engine running and therefore had a hot board.

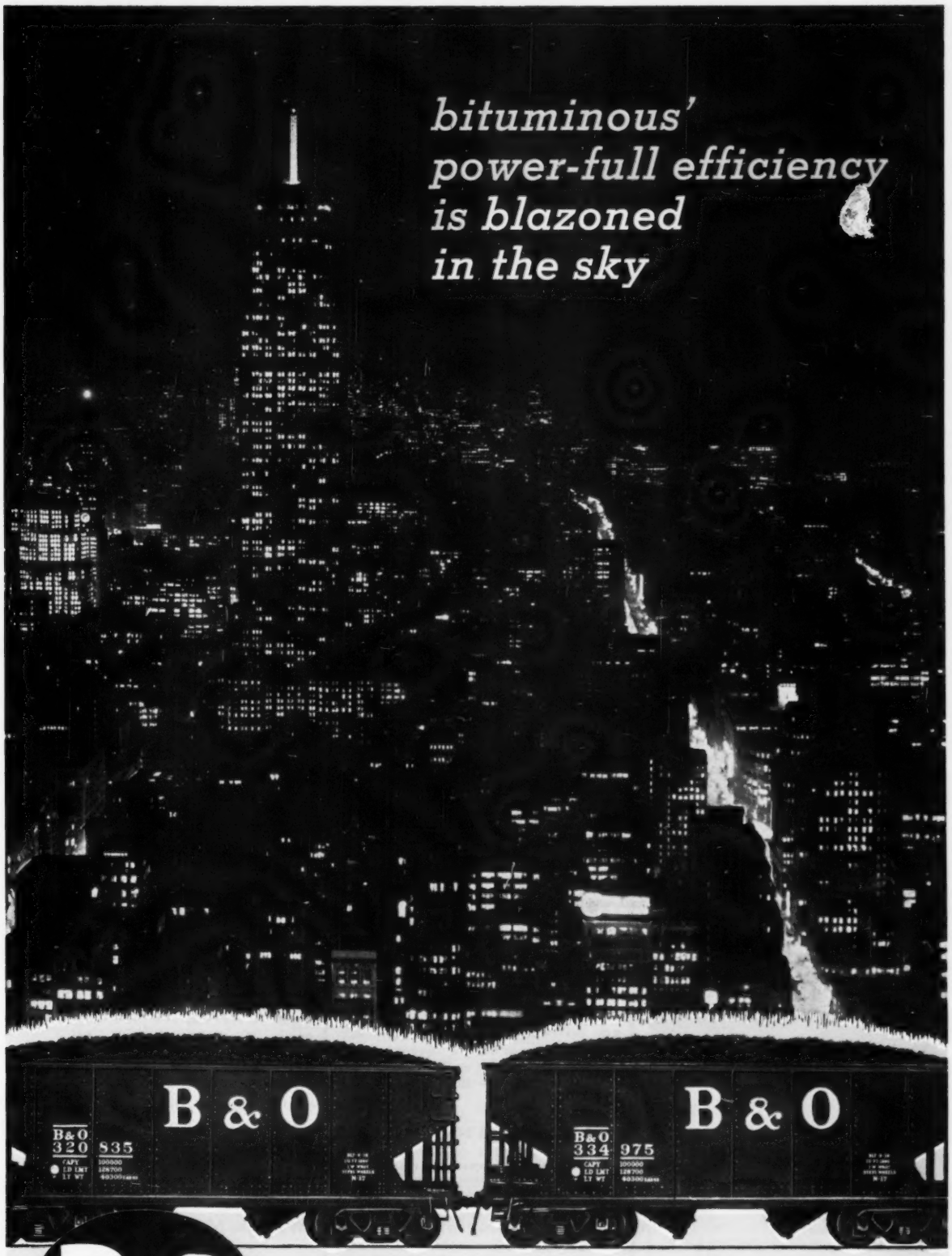
A B HARPER, *Rochester, N. Y.*

More FREE LITERATURE

Begins on page 161

CONTROLS, ELECTRICAL AND MECHANICAL

11 **Electromagnetic control** and solenoid valves are described in seven electromagnetic control catalogs. Designated 57-S1, 57-S2, 57-S3, 57-S4, 57-S5, 57-S6 and 57-S7, these catalogs contain cutaway drawings and specs. Request direct on



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PYREX brand PLATE GLASS No. 7740 is particularly suited for odd-sized sight glasses, fume duct windows, and chemical-resistant surfacing. You can use it for temperatures up to 900° F. It is resistant to thermal shock and indifferent to chemical attack.

VYCOR brand FLAT GLASS No. 7900 has such resistance to thermal shock that you can use it with continuous temperatures to 1450° F., intermittently at 2210° F.; for high-temperature furnaces and tanks.

PYREX brand INFRARED-REFLECTING GLASS reflects radiation in the infrared spectrum but transmits up to 75% of visible light. Useful as an efficient shield to protect workmen from exposure to intense heat radiation.

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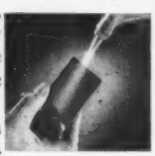

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Company.....

Address.....

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More FREE LITERATURE

Begins on page 161

company letterhead. The Automatic Switch Co, Florham Park, N. J.

12 **Automatic package controls** are described in 16-p illustrated catalog AC-2. Applications discussed include control of temperature, torque viscosity, current, voltage, time of welding and others. Tipp-Tronic, Inc, Tipp City, Ohio.

13 **Electric thermostat** is subject of 4-p illustrated bulletin RT-803. Contains information and diagrams concerning application and installation. Robertshaw Fulton Controls Co, 110 E Otterman St, Greensburg, Pa.

14 **Temperature regulators** are discussed in 4-p illustrated bulletin. Includes cross-section photos and engineering drawings, construction features, principles of operation, specs and table of dimensions and weights. Cash Standard Stacon Corp, Box 551, Decatur, Ill.

15 **Steam and liquid control** valves are described in illustrated condensed catalog 57. Covers pressure and temperature regulators; solenoid, diaphragm, motorized and float valves; pressure reducing, flow control, safety and relief valves; and strainers. O C Keckley Co, 3402 Cleveland St, Skokie, Ill.

16 **Pressure regulators** for industrial compressed gases is subject of 40-p illustrated catalog 806. Contains information on cylinder, manifold, and pipeline regulators and specialized equipment. Includes flow and pressure charts. Air Reduction Sales Co, 150 E 42nd St, New York 17, N. Y.

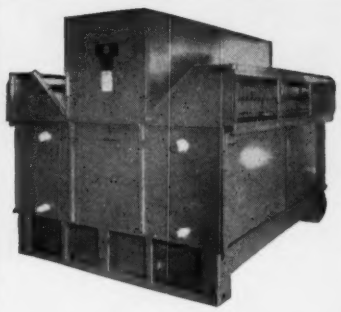
17 **Disconnect switches** for medium transformers are described in 2-p illustrated catalog GEA-6246A. Contains diagrams and photos illustrating construction and operation. General Electric Co, Schenectady 5, N. Y.

18 **Instruments** and controls are subject of spec digest. Condensed 12-p catalog is designated 57-687-297. The Hays Corp, Michigan City, Ind.

ELECTRICAL EQUIPMENT

19 **Instrument transformer** 1957 Buyer's Guide (GEC-1028B) contains price and product information on complete instrument transformer line. Illustrated 90-p catalog uses picture-caption technique for easy reference. General Electric Co, Schenectady 5, N. Y.

20 **Transformers** of the linear variable differential type are subject of 19-p illustrated bulletin AA-1a. Explains operation of unit and summarizes mechanical and elec-



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That's why engineers at A. B. Farquhar Division of The Oliver Corporation, York, Pa., specify Garlock CHEVRON exclusively for the main rams and pull back rams of this press. CHEVRON's unique construction permits free operation of rams at all pressures. It automatically tightens or eases-off as pressures increase or decrease . . . prevents leakage without hampering operation.

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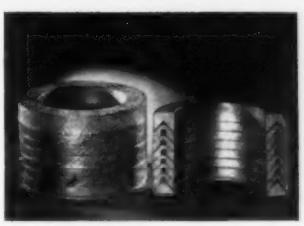

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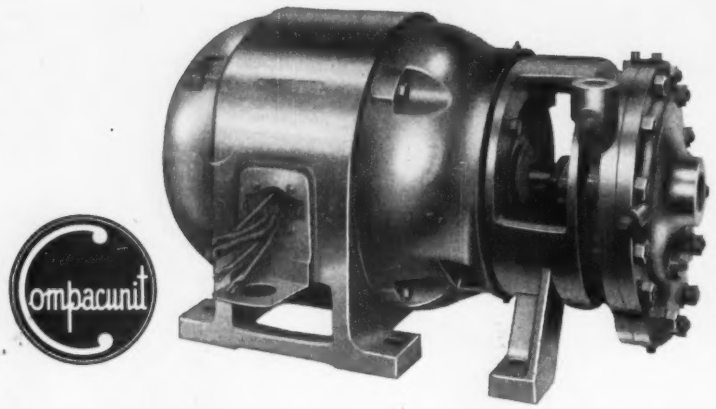

Type 1CH 2-stage pump is designed and priced for low-capacity, high head jobs

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Heads - 200 to 375 ft.

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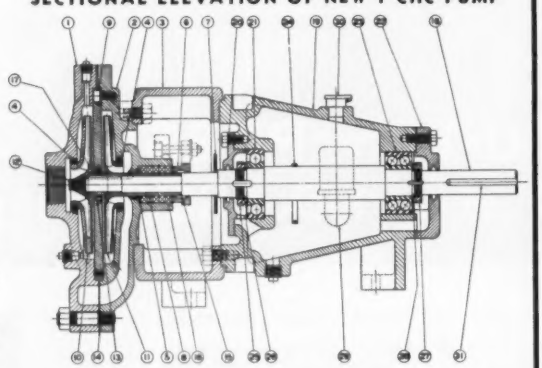

DESIGNATIONS

1. Casing—1st Stage
2. Casing—2nd Stage
3. Frame
4. Case Ring
5. Stuffing Box Bushing
6. Gland
7. Flinger
8. Shaft Sleeve
9. Center Section
10. Impeller—1st Stage
11. Impeller—2nd Stage
12. Impeller Nut
13. Center Section Bushing
14. Gasket
15. Gasket
16. Packing Anchor No. 317
17. Impeller Key
18. Shaft

RATING CHART

1-CH or 1-CHC Bulletin									
HD	GPM	5	10	15	20	30	40	50	60
275		7½	7½	7½	7½	7½	7½	10	10
300		7½	7½	7½	7½	7½	7½	10	10
325		7½	7½	7½	7½	7½	10	10	
350		7½	7½	7½	7½	10	10		
375		7½	7½	7½	7½	10			

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PART	STANDARD	ALL IRON	ALL BRONZE
Suction Head	Cast Iron	Cast Iron	Bronze
Casing	Cast Iron	Cast Iron	Bronze
Impeller	Bronze	Cast Iron	Bronze
Impeller Nut	Bronze	Stainless Steel	Bronze
*Shaft	Steel	Steel	Steel
*Shaft Sleeve	Bronze	Cast Iron	Bronze
Seal Cage	Cast Iron	Cast Iron	Bronze
Gland	Cast Iron	Cast Iron	Bronze
Flinger	Cast Iron	Cast Iron	Cast Iron
Frame	Cast Iron	Cast Iron	Cast Iron

*Shaft sleeves available in Nitralloy Nitrided, Hardened Stainless steel or Monel and shafts in Stainless Steel or Monel on special order.

ASK FOR BULLETIN NO. 242

WARREN

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G-7

More FREE LITERATURE

Begins on page 161

trical features. Shaevitz Engineering, Box 505, Camden 1, N. J.

21 **Thermistors** are discussed in 10-p illustrated bulletin T-100. Lists typical applications and circuitry. Gives specs and characteristics of wafer, rod and bead thermistors Mr Lawrence C Oakley, Thermistor Div, Gulton Industries, Inc, 212 Durham Ave, Metuchen, N. J.

22 **Weather protected motor** bulletin describes features which contribute to outdoor dependability of units in ratings from 250 to 900 p. Five-page illustrated bulletin 51B8606A contains specs, diagrams and photos.

★ **Fabrication** of electrical transmission substations is described and pictured in 8-p illustrated bulletin. Explains the use of standardized modular trusses and small parts. ★Request direct on company letterhead. Charles S Schuler Engineering Co, Newark, Ohio.

23 **De timing motors** are subject of 2-p illustrated bulletin sheet AWH MO 805. Contains information on function and an explanation of construction and operation. Features cut-away view of basic unit. Request direct on company letterhead. The A W Haydon Co, Waterbury, Conn.

24 **Electric clips** are described in 8-p illustrated catalog 200. Provides complete description and illustration of every clip in the line. Mueller Electric Co, 1593V E 31st St, Cleveland, Ohio.

25 **De hypots** for high-potential testing of high voltage cables, insulation materials, large rotating machinery and related high-voltage equipment are described in 3-p illustrated bulletin 5-1.1. Associated Research Inc, 3770 Belmont Ave, Chicago 18, Ill.

26 **Motor catalog,** 1957 condensed edition, covers current pricing for 1/20 through 200 hp motor sizes on general purpose fractional and integral hp motors. Includes slide base dimensions with diagrams and adapter information. Also includes standard modifications and dimension drawings. Marathon Electric Mfg Corp, Wausau, Wis.

SAFETY EQUIPMENT AND MATERIALS

27 **Fire detector** is described in illustrated 12-p bulletin. Outlines how system operates and lists several hundred industrial, commercial, institutional and government users of the equipment. Walter Kidde & Co, Inc, Belleville, N. J.

28 **Fire protection** systems, their nature and advantages are subject of 34-p illustrated bulletin 66. Contains complete explanation of insurance savings and other economic benefits which fire protec-

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Silicone Insulated Transformers Give Greater Reliability

For an extra measure of reliability plus greater overload capacity — specify dry-type transformers insulated with Dow Corning Silicones. They're so completely safe you can locate them almost anywhere. Easier and less expensive to install than liquid-filled types, they offer virtual freedom from maintenance, superior resistance to high ambients, moisture and corrosive atmospheres.

For Underground Distribution, sealed dry-type network transformers with the higher thermal capacity of silicone insulation can handle temporary overloads up to 25% above rating. There's no oil to maintain, so you can "bury them and forget them."

For Station Auxiliary Power specify silicone insulated **sealed** dry-type transformers for lowest installation costs, greatest reliability and easiest maintenance . . . or the **open** dry-type for the lightest floor loading. Both hold down installation costs, require no vaults, barriers or ventilators. There's never any danger of fire, explosion, or toxic fumes and there are no liquids to maintain.

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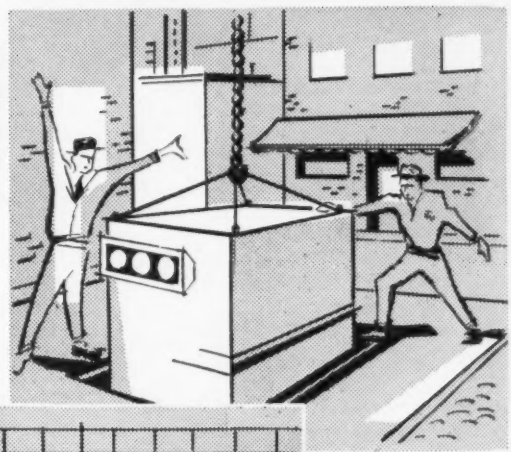

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Sealed Dry-Type Units for Minimum Maintenance

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Open Dry-Type Units are 15% Lighter

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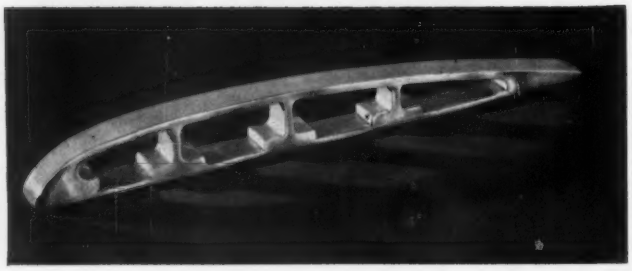

Cross section shows structural superiority of Aeromaster's new, extruded aluminum-alloy blades in diameters from 9′ to 22′.

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AEROMASTER'S new, extruded aluminum blades combine in one design the advantages of a light weight metal, a hollow structure and the superior strength of wrought metal... Silicon-magnesium aluminum alloys resist corrosion. Their fine grain structure, high tensile strength and increased endurance eliminate danger from wear, vibration, and metal fatigue... true airfoil blade sections assure maximum air delivery... adjustable blade pitch angle permits decrease of fan load to an accurate minimum horsepower requirement.

The AEROMASTER fan is easily assembled *in the tower.* No special handling equipment is necessary. AEROMASTER fans cost less to install, less to operate, less to maintain!

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More FREE LITERATURE

Begins on page 161

tion makes possible. Includes descriptions and pictures of complete range of fire protection components and accessories. "Automatic" Sprinkler Corp of America, Youngstown 1, Ohio.

MAINTENANCE EQUIPMENT AND MATERIALS

29 **Motor care** is subject of two bulletins, 51X8581 and 51X8582. Story of good and bad maintenance is told in cartoon form and is taken from two 20-minute films. Allis-Chalmers Mfg Co, Main office, Box 512, Milwaukee 1, Wis.

30 **Epoxy resins** for protection of all forms of large electrical apparatus are discussed in 24-p illustrated bulletin entitled *The Epoxylite Story.* Includes a question and answer section on materials and special processes offered to industry and contains cost comparison data. The Epoxylite Corp, 10829 E Central Ave, El Monte, Calif.

MATERIALS HANDLING

31 **Belt conveyor idlers** are described in 8-p illustrated bulletin 119. Describes construction, lists standard sizes, dimensions and weights. The C O Bartlett & Snow Co, 6200 Harvard Ave, Cleveland 5, Ohio.

WELDING

32 **Simplified automatic** and semi-automatic welding are described in 3-p illustrated bulletin. Describes new controlled arc power supply available. Metal & Thermit Corp, Rahway, N. J.

33 **Hardfacing** and manganese electrodes are described in 20-p illustrated bulletin. Recommended application procedures are shown, together with the type and quantity of material required and the range of machine settings for each. The Sight Feed Generator Co, West Alexandria, Ohio.

LUBRICATION

34 **Premium greases** designed for water and high-temperature conditions are described in 2-p illustrated bulletin 50. Sun Oil Co, 1608 Walnut St, Philadelphia 3, Pa.

35 **Lubricant testing machine** is described in 2-p illustrated bulletin 106. Operation is diagrammed. The Alpha Molykote Corp, Stamford, Conn.

First of two 100,000-kw units of the Agua Fria steam electric generating plant was put into commercial service April 1 by the Salt River Power District at Phoenix, Ariz. Construction of the second unit will be completed by Jan 1. Total plant cost will be $26 million.

You can't buy a better flange...

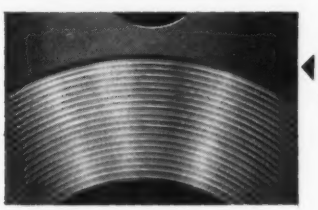
Forged Steel. Shot Blasted. All Phoenix flanges meet full A.S.A. specifications — carbon steel and alloy.

Spot faced bolting surfaces, extra fine facings, accurate threading and a protective coating are typical of Phoenix quality.

Precisely machined welding bevel.

Special facings, bores, drilling, threading and special machining available.

The long life and precision workmanship you have a right to expect in the flanges you buy are assured when you order Phoenix forged steel flanges. You simply can't buy a better flange! It costs no more for Phoenix quality and *service*. That's why it's always worthwhile discussing your pipe flange requirements with the Phoenix representative.



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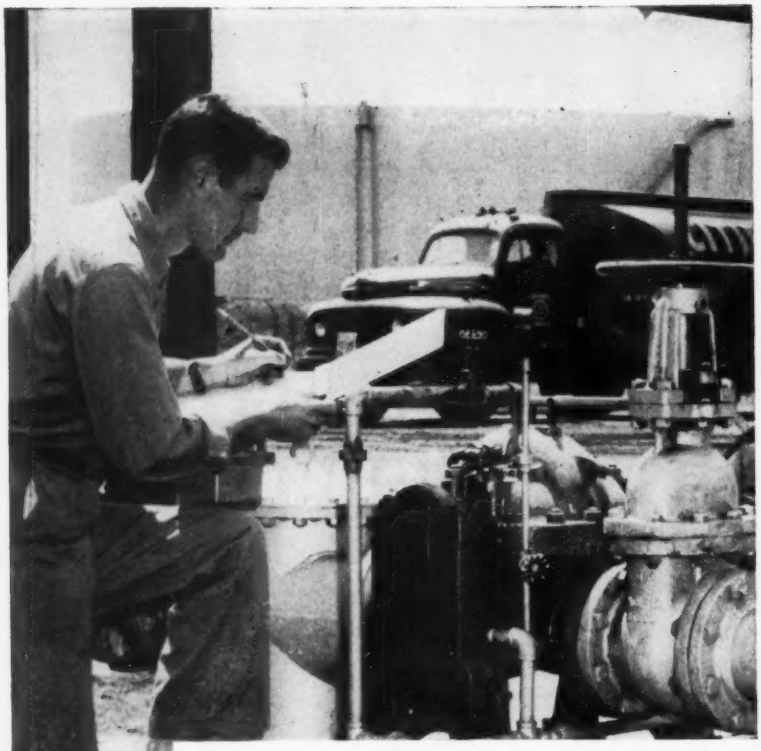

Pump capacity . . . ✓

If it's capacity you want, check the Goulds Fig. 3405 single-stage suction pump. You'll get capacity all right—*and much more!*

You can pump at any rate from 200 GPM to 6400 GPM with one of the 19 available sizes. And you can save money, too, because of these built-in cost advantages:

Interchangeability of parts—Only three shaft and rotating-parts assemblies provide for 19 pump sizes and 38 pump combinations.

Standard "custom" features—*Every* Fig. 3405 pump has sealed bearing housings, renewable stuffing box bushings, Teflon water seal rings, stainless steel impeller keys, cowl-type glands, die-formed stuffing box packing, and corrosion-resistant gland bolts.

Compact construction—Short bearing spans cut pump lengths as much as 50 percent—which means less floor space.

Flexibility of stuffing box—You can change from conventional stuffing boxes to mechanical seals in the field.

Easy rotation change—Its unique design permits you to change the direction of rotation in the field.

When you check *capacity*, you'll find it in a Goulds Fig. 3405—and more besides. Call your Goulds representative or drop us a card. Ask for Bulletin No. 721.6.

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More TECHNICAL BRIEFS

Begins on page 148

The dose rate to an organ from such ingestion depends on the quantity ingested, the fraction reaching the critical organ, the effective energy, effective half-life, time of exposure and the mass of the critical organ, as discussed in *Handbook 52* of the National Bureau of Standards.

The authors refer to techniques that have been developed for the identification of specific radionuclides in natural waters, bottom muds and solids and in vegetation. They briefly describe procedures for determination of radium, cobalt, strontium, barium, cesium and other fission products in various media. *NESC paper No. 57-88.*

Radioactive tracers in the field of sanitary engineering. *By C P Straub and G R Hagee, Robert A Taft Sanitary Engineering Center.*

The authors describe studies in which radioactive tracers were used singly or in combination with either dye or chemical tracers to define the flow time in streams, pilot-plant facilities and pasteurization equipment. The isotopes used were rubidium-68, bromine-82 and iodine-131. Various types of instrumentation were also employed, including proportional counters, G-M end window counters, field scalers, survey meters and a gamma scintillation counter. *NESC paper No. 57-87.*

Separation of cesium and strontium from calcined metal oxides as a process in disposal of high level wastes. *By A Abriss, J J Reilly and E J Tuthill, Brookhaven National Laboratory.*

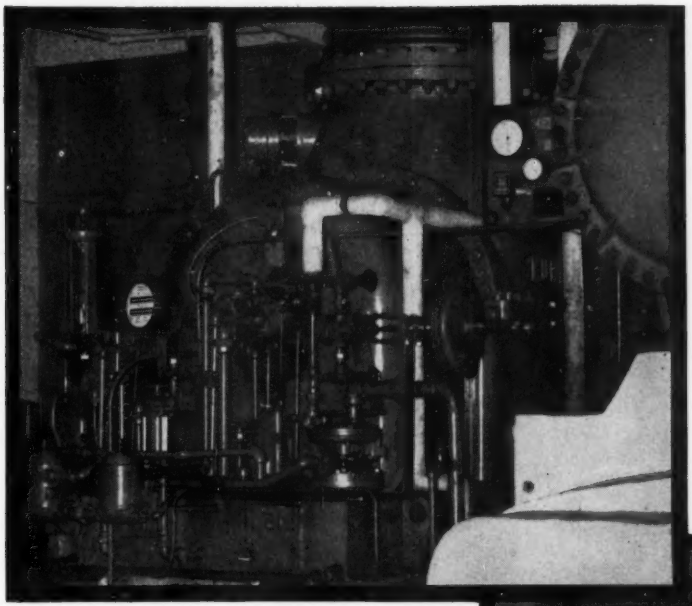
In the ultimate disposal of reactor wastes by fixation of fission products in stable solids, conversion of bulk metal ions, such as aluminum and zirconium, to their insoluble oxides is highly desirable. Leaching of soluble fission products, cesium and strontium, from the insoluble oxides for subsequent use or disposal is the main subject of this paper. *NESC paper No. 57-53.*

Nuclear power plants

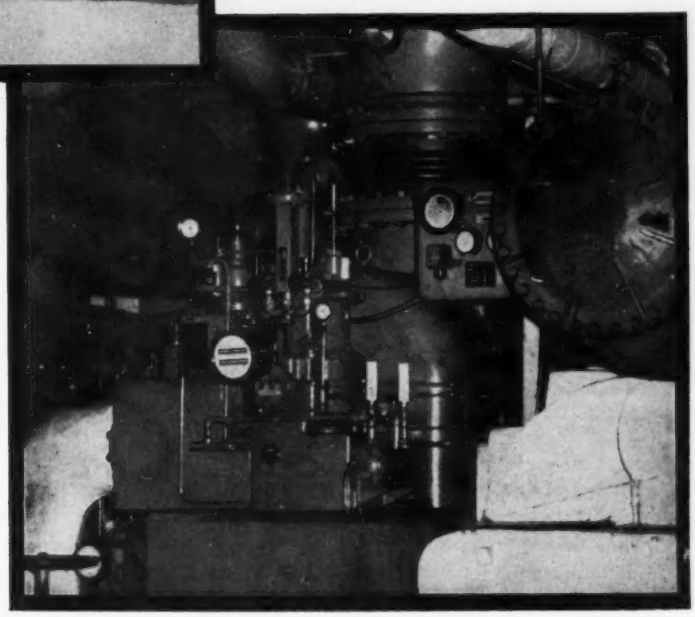
Some operational problems of the nuclear power plant. *By A R Jones and R L Witzke, Western Electric Corp.*

The pressurized water reactor derives heat energy from the fission of uranium and other heavy atoms, which are maintained in a fuel structure of solid rods or plates, inside a reactor or pressure vessel. This energy is transported in hot

Directions for ordering papers on page 210



1948—For air conditioning drive B. Altman & Co. installed a Murray low pressure turbine providing 633 HP at 5010 RPM.



1950—Again B. Altman & Co. selected Murray to drive another air conditioning unit with a 905 HP, 3880 RPM low pressure turbine.

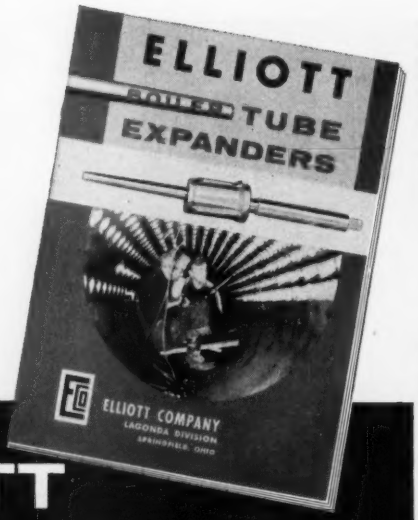
ALTMAN'S SCAVENGES LOW PRESSURE STEAM FOR AIR CONDITIONING DRIVE

B. Altman & Co. in New York City are utilizing low pressure steam to power the air conditioning of their large department store at 34th Street and Fifth Avenue. Economical Murray turbines operating on exhaust steam at only 2# gauge pressure provide the smooth dependable power for the store's two centrifugal compressors. Your low pressure steam can be utilized just as effectively to drive any type of machine. Murray's low pressure turbines are developing as much as 2200 HP in a single turbine and of course Murray's long experience assures you af an added plus value of service and long life.

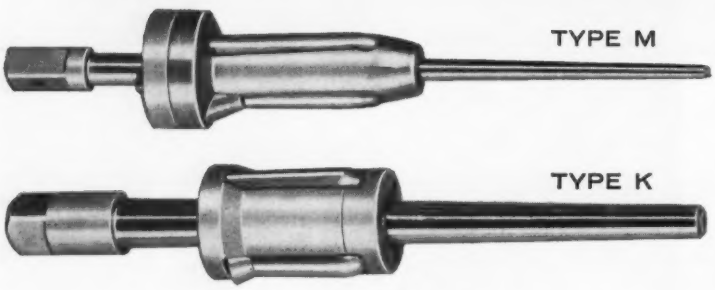
Consult your local Murray representative who will be pleased to show you ways of utilizing your low pressure steam. MURRAY IRON WORKS COMPANY, Burlington, Iowa.

★★ **Murray Turbines** ★★

write for your copy of this Bulletin!



ELLIOTT
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up



This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A new heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

RIGHT-ANGLE GEAR DRIVE ▸
Available in ½, ¾ and 1-in. sizes

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Y7-5

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More TECHNICAL BRIEFS

Begins on page 148

water, approximately 2000 psia and 500 to 600 F, to the steam generator where water in a separate system is boiled to produce steam for the turbine.

Depending on plant size, one or more heat transfer loops and steam generators may be used to remove the heat from a single reactor. The water in these loops is maintained with less than 2 ppm impurities by a purification system. A makeup and drain system, with connections to a water supply of high purity and a waste-disposal system, is required to keep the appropriate water level in the 2000 psia system. When heat energy is not required to drive the turbine, heat must be removed from the reactor by the shutdown cooling system. Reactor control and radiation monitoring of high reliability are required for plant safety.

The authors discuss problems of start-up, normal operation, shutdown, maintenance, refueling, manpower. *NESC paper No. 57-24.*

Gas coolant for nuclear reactors. *By M Silverberg, Ford Instrument Co.*

The closed-cycle gas-cooled reactor is unique in many respects. Not the least of these is that it uses a power plant that, as yet, has not been completely proven. This is in contrast to existing nuclear power plants where the prime mover and associated equipment have been of conventional design with only minor modifications to suit the situation at hand.

Information now available concerning closed-cycle turbine operation deals with air as a working medium. Most gas-cooled reactor designs propose use of helium or nitrogen.

The author discusses the status of closed-cycle gas-cooled reactor power plants. He considers the advantages and disadvantages of this type of system, with particular emphasis on some of the problem areas brought to light by design studies and their potential effect on the future of the reactor. *NESC paper No. 57-76.*

Use of boiling water as a reactor coolant. *By S Untermeyer, General Electric Co.*

Certain developments can be discerned relating to future development of boiling reactors. Perhaps the major trend is toward the use of higher temperatures and pressures. The first boiling reactors were designed to operate at "convenient" pressures in relation to pressure vessel wall thickness, fuel

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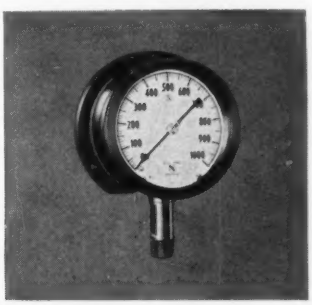

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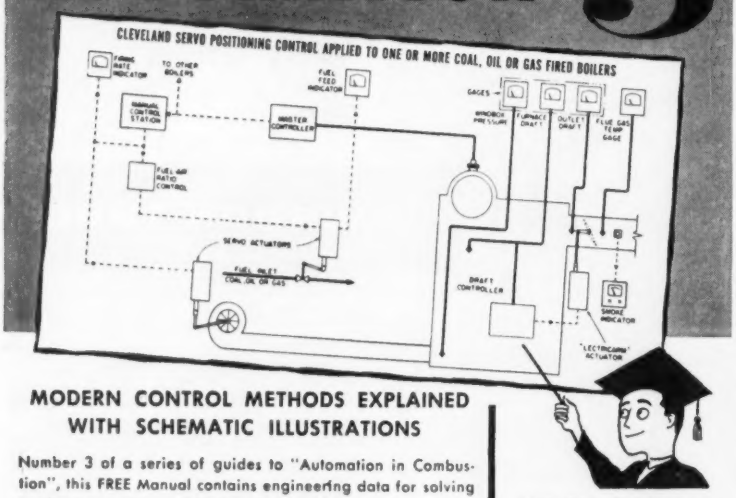

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Begins on page 148

capabilities, and turbine exhaust moisture content. Pressures presently used range from 300 psi for "Borax" up to over 1000 psi for the GE developmental BWR.

Whenever steam void content is excessive, other measures such as forced circulation or dual cycle are used to maintain performance. The capability of a boiling reactor to operate at equivalent thermal efficiency, but at much lower pressures has given this design marked advantages over types using nonboiling water. Methods are now being developed to optimize performance of the reactor core.

The next logical development would be an increase in pressure until supercritical steam conditions prevail within the reactor. *NESC paper No. 57-80.*

Heat transfer considerations in the use of organic reactor coolants. *By T T Shimazaki and W F Anderson, Atomics International.*

A number of organic fluids are being investigated for possible use as the primary coolant in nuclear power reactors. The advantages offered by these organic fluids include a low pressure system, a compact core, simplified core construction because of the combined moderator and coolant, and a coolant that is relatively cheap, noncorrosive to most materials, activated only slightly and nonreactive with uranium and with water.

There are, however, a number of limitations associated with the heat transfer characteristics of organic reactor coolants in practical applications. Some of the heat transfer considerations discussed in this paper are (1) relationship between coolant channel geometry, thermal power and pressure drop in a surface temperature limited system (2) stability of parallel flow with temperature dependent surface fouling (3) change in heat transfer coefficient because of radiolytic damage (4) burnout heat flux (5) thermal stress problems. *NESC paper No. 57-113.*

Dynamic simulation of a fast reactor system. *By R G Olson, Atomic Power Development Associates, Inc.*

The APDA simulation program was started in 1955 to determine the control of the reactor plant. The first study consisted of a core representation only. In that study, most of the cases showed that the reactor was able to accommodate the incident. Cold slug incidents

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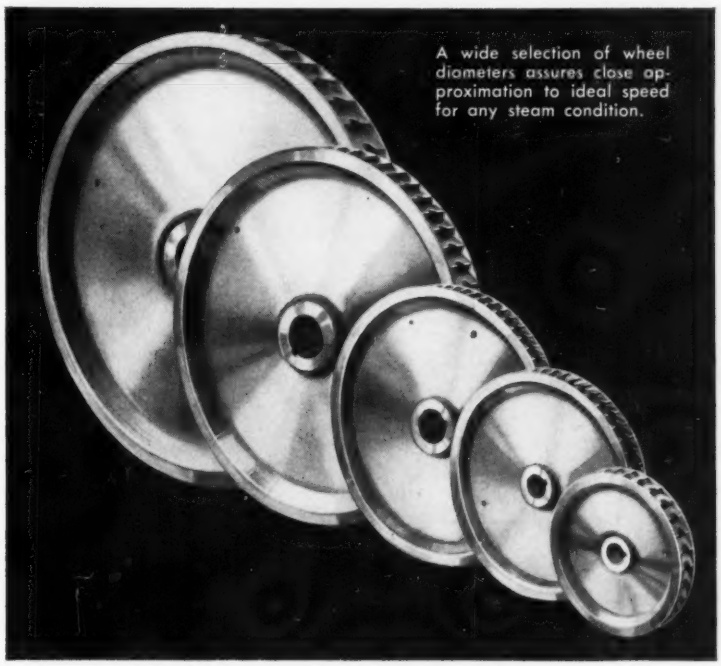

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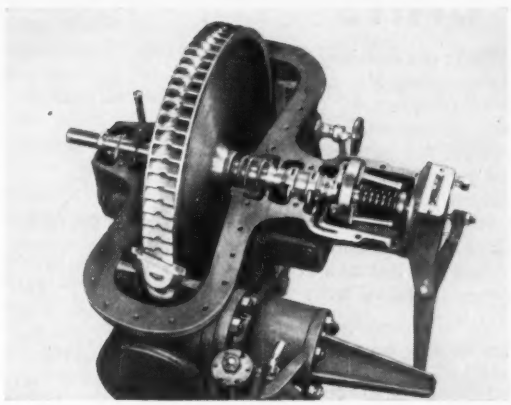

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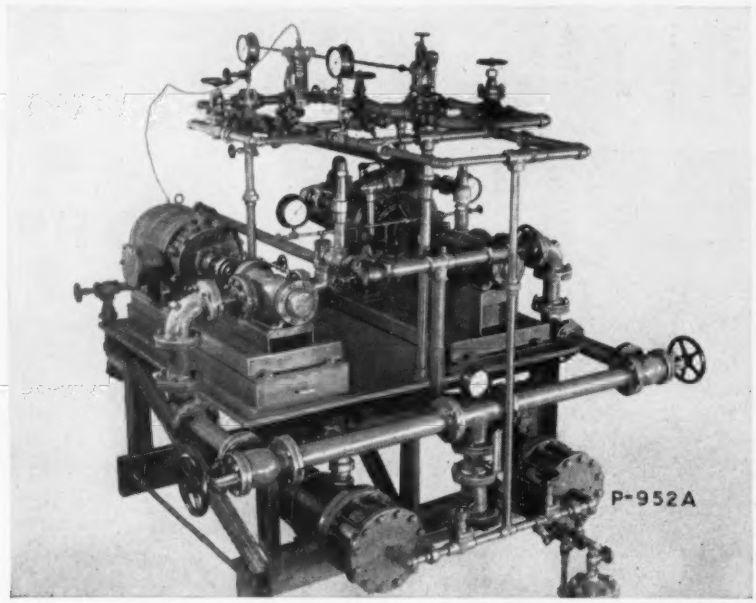

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gave small concern, except for thermal shock, because of the small temperature coefficients.

However, the two situations presented in this paper did lead to possible fuel melting. Both of these are caused by multiple failure of control and scram systems. Therefore, temperature effects of blanket, top structure and Doppler effect have been added. Results of these added mechanisms are given. *NESC paper No. 57-25.*

Design and development of the coolant system for the Sodium Reactor Experiment. *By D T Eggen, A M Stelle and M Heisler, Atomics International.*

The Sodium Reactor Experiment (SRE) will be the principal tool for the development of the technology associated with the sodium-cooled, graphite-moderated type of reactor. The program was initiated in June, 1954.

Engineering for the SRE has included, in addition to the actual design work, an analytical and experimental program of the various components in the system.

Piping arrangements and component equipment have been designed which appear to offer a practical solution to the problems involved. Stress, thermal expansion and preheating systems have been engineered for the four sodium circuits and for the intermediate heat exchangers.

Components have been designed, developed, and tested. They include pumps, valves, cold traps, venting systems, coolant instrumentation. The results of this engineering and development work are described in detail for the heat transfer systems. Stress and heat transfer data and experimental results are discussed. *NESC paper No. 57-115.*

Corrosion

Corrosion control on underground structures in power plants. *By R M Wainwright, Good-All Electric Manufacturing Co, and D P Price, Montana-Dakota Utilities Co.*

For many years power-plant operators have paid considerable attention to boiler-feedwater treatment to prevent corrosion and scaling of boilers, piping and other internal metal surfaces. Much less attention has been paid to external corrosion of metal structures buried in the soil around and under the power plant proper and in the plant and substation yards.

Underground corrosion is usually

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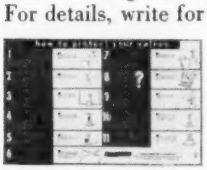

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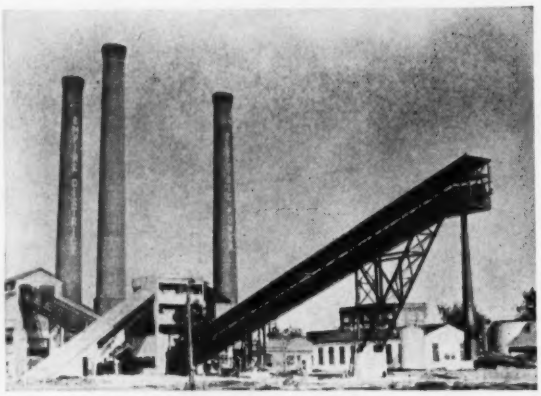

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caused by three principal factors: (1) ordinary soil corrosion caused by single-metal galvanic cells (2) soil corrosion caused by multimetal galvanic cells (3) stray direct current corrosion. Ordinary soil corrosion is probably the most important.

Successful corrosion - control techniques may be divided into (1) coatings and cathodic protection (2) elimination or re-arrangement of bi-metallic cells (3) elimination of stray direct currents. *APC paper, no number.*

Cathodic protection—corrosion control in water. *By L P Sudrabin, Electro Rust-Proofing Corp.*

There are four basic methods of corrosion control by which the designer or operator can reduce losses caused by metal destruction. These are (1) corrosion-resistant materials (2) protective coatings (3) treatment of the environment (4) cathodic protection. Each has special adaptabilities and advantages. None are cure-alls.

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Hydro

The electrical features of the St. Lawrence Power Project. *By J Saloma, Charles T Main, Inc.*

This paper covers the electrical features on the American half of the St. Lawrence Power Project. In general, the design on both the American and Canadian sides is similar, differences existing only where engineering or manufacturing standards differ.

The paper also gives a brief description of the entire St. Lawrence Power and Seaway Projects, including the Long Sault and Iroquois dams, the Massena intake, and the Barnhart Island power dam.

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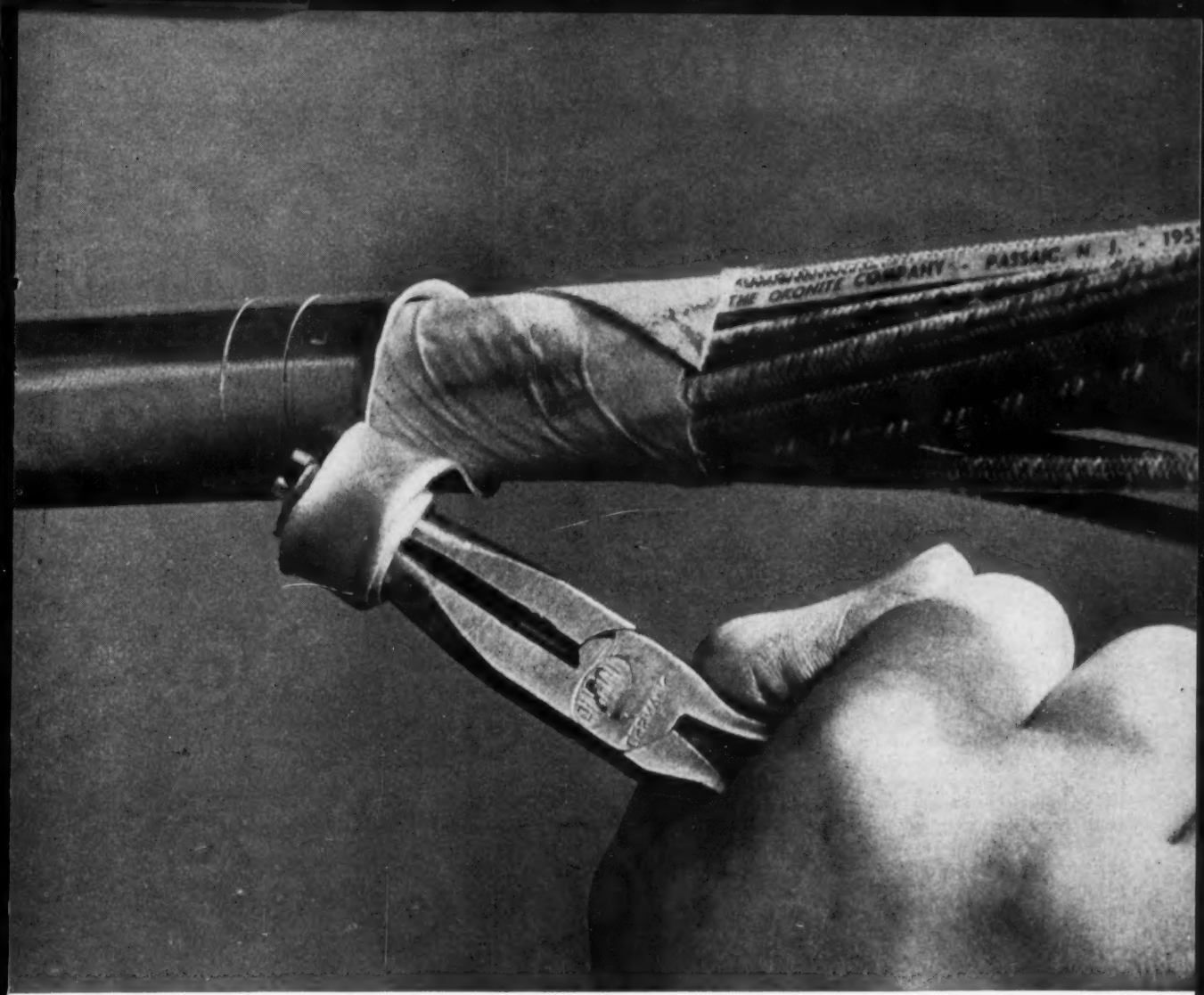

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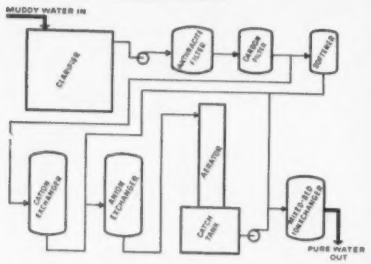

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kwhr per year. The secondary capacity will be about 240,000 kw with an estimated secondary energy output of 1.3 billion kwhr per year. Capacity of this plant ranks second only to Grand Coulee Dam on the Columbia River. *AIEE paper No. 57-653.*

Vertical waterwheel turbine clearance adjustment through the controlled deflection of generator thrust bearing supports. *By D K Venus and C C Sargeant, Canadian Westinghouse Co, Ltd.*

Paper describes the special motor-generators for the Hydro Electric Power Commission of Ontario's pumped storage project, Sir Adam Beck at Niagara Falls, Ontario. The motor generator is direct connected to a single-runner vertical - shaft hydraulic pump-turbine of the mixed-flow reversible type.

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American Power Conference, 18th annual meeting. Identified by initials APC and obtainable through purchase from Director, APC, Illinois Institute of Technology, Chicago 16, Illinois.

Nuclear Engineering and Science Conference, 2nd annual meeting. Identified by initials NESC and obtainable from American Society of Mechanical Engineers, 29 W 39th St, New York 18, New York.

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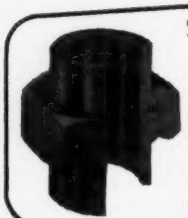

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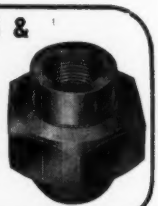

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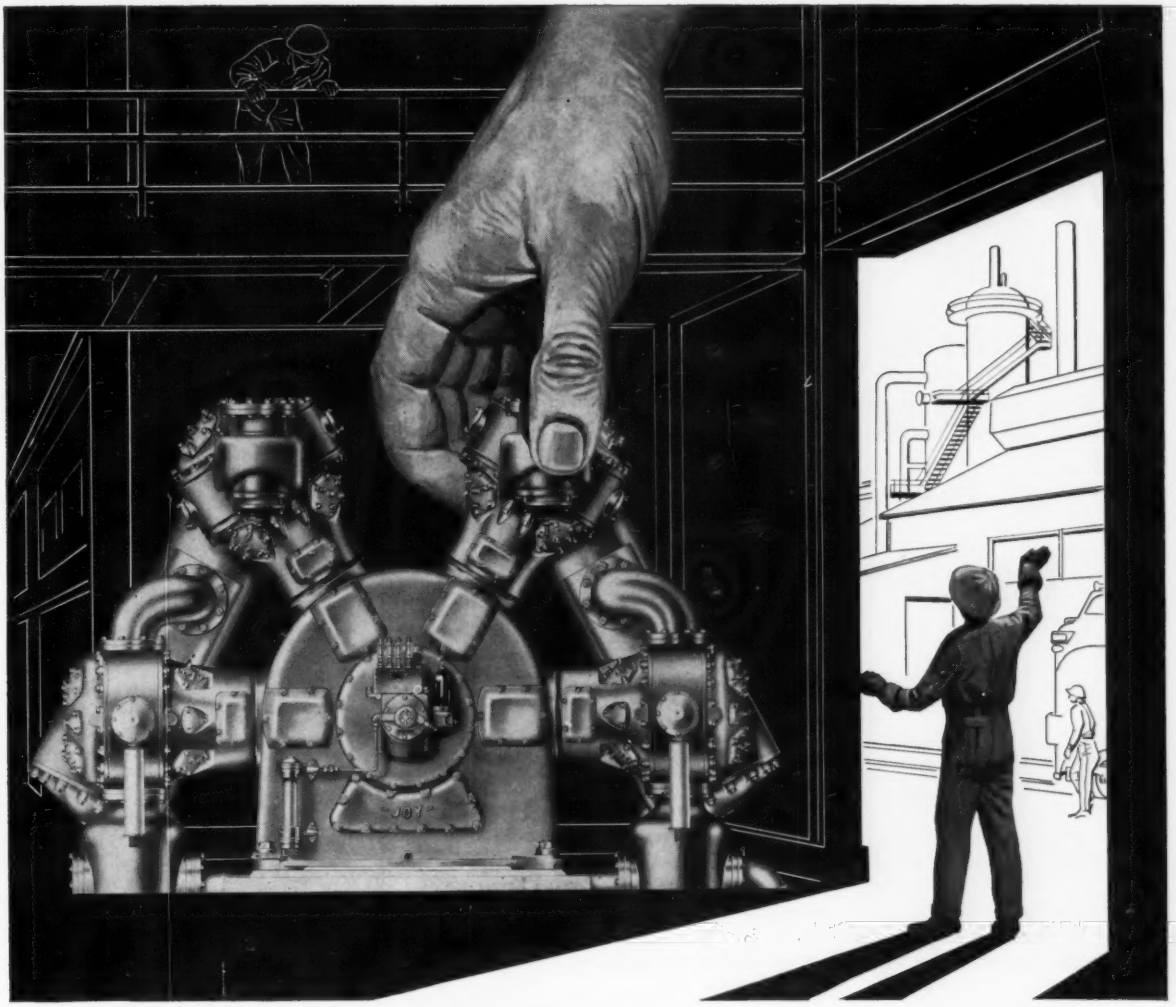

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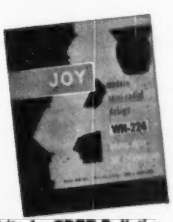

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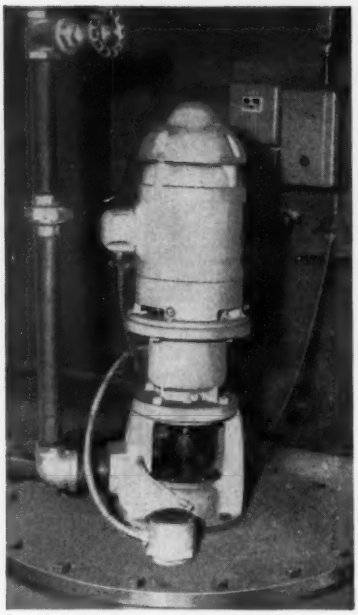

One of six Deming Turbine Pumps in condensate return service at The Morgan Engineering Company, Alliance, Ohio.

Deming Turbine Pumps

Plant engineers at The Morgan Engineering Company, Alliance, Ohio, leading manufacturer of cranes, presses and steel mill equipment, had a "package" of pump problems.

The Job was pumping hot condensate from steel sumps for return to steam boilers.

The Equipment included four obsolete condensate pumps with 3 HP electric motors and float controls.

The Problem was the failure of the original equipment to meet the job requirements efficiently and economically. Proper lubrication of the pump bearings was found impossible to provide. Frequent replacements of bearings and impellers was necessary. Float equipment gave almost constant trouble due to surges of steam. Here was a "package" of problems.

The Solution started by calling in the local Deming Distributor. Working "elbow to elbow" with the plant engineers, it was decided that Deming Vertical Turbine Pumps offered definite advantages.

1. The Deming Vertical Submerged Pumps with floatless controls eliminated the former float control troubles.

2. Only 2 HP electric motors were required by the Deming Turbine Pumps. The former condensate units required 3 HP motors.

3. Trouble in lubricating the bronze bearings of the condensate units was eliminated. Deming Turbine Pumps are self-lubricating (with the water flowing constantly through the pump when operating).

4. Using 1/3 less horsepower, the Deming Turbine Pumps did more work with a minimum of maintenance and at considerably less overall cost of operation.

Ask your nearest Deming Distributor or write us for a free copy of illustrated BULLETIN 4700 on Deming Vertical Turbine Pumps.

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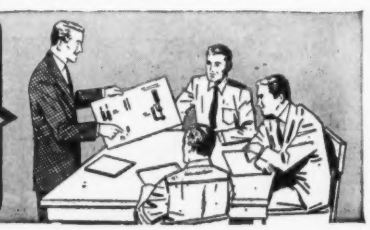
CALL YOUR **DEMING DISTRIBUTOR** *for help on pumps!*



APPOINTMENTS

Corporation executive changes

The Babcock & Wilcox Company: M Nielsen, president, succeeding Alfred Iddles, retired; J E Brinckerhoff, vice-president. **Westinghouse Electric Corporation:** Carroll V Roseberry, John H Chiles Jr and B M Brown, vice-presidents. **Iron Fireman Manufacturing Company:** Lewis Cox, 1st vice-president and director. **Fischer & Porter Co:** Robert F Lane, executive vice-president.

The William Powell Company: George W Mueller, V Anderson Coombe, John A Parlin and Russell G Smith, vice-presidents. **A-P-D Company,** affiliate of Minnesota Rubber and Gasket Company: Richard E Tisch, vice-president, product development; W A McGee, vice-president, materials development. **The Perolin Company,** J F Scott, vice-president. **The Wayne Pump Company:** Charles H Godschall, vice-president, planning and production.

Lockwood Greene Engineers, Inc: Edward B Moebus and Samuel B Roberts, vice-presidents. **Combustion Engineering, Inc:** Samuel R Parry, vice-president. **McGraw-Edison Company,** Pennsylvania Transformer division: F E Stouffer, vice-president and plant manager. **Crane Co:** Joseph W Greene, vice-president, sales. **Anderson Electric Corporation:** C E Bitzer, vice-president, sales.

New sales managers

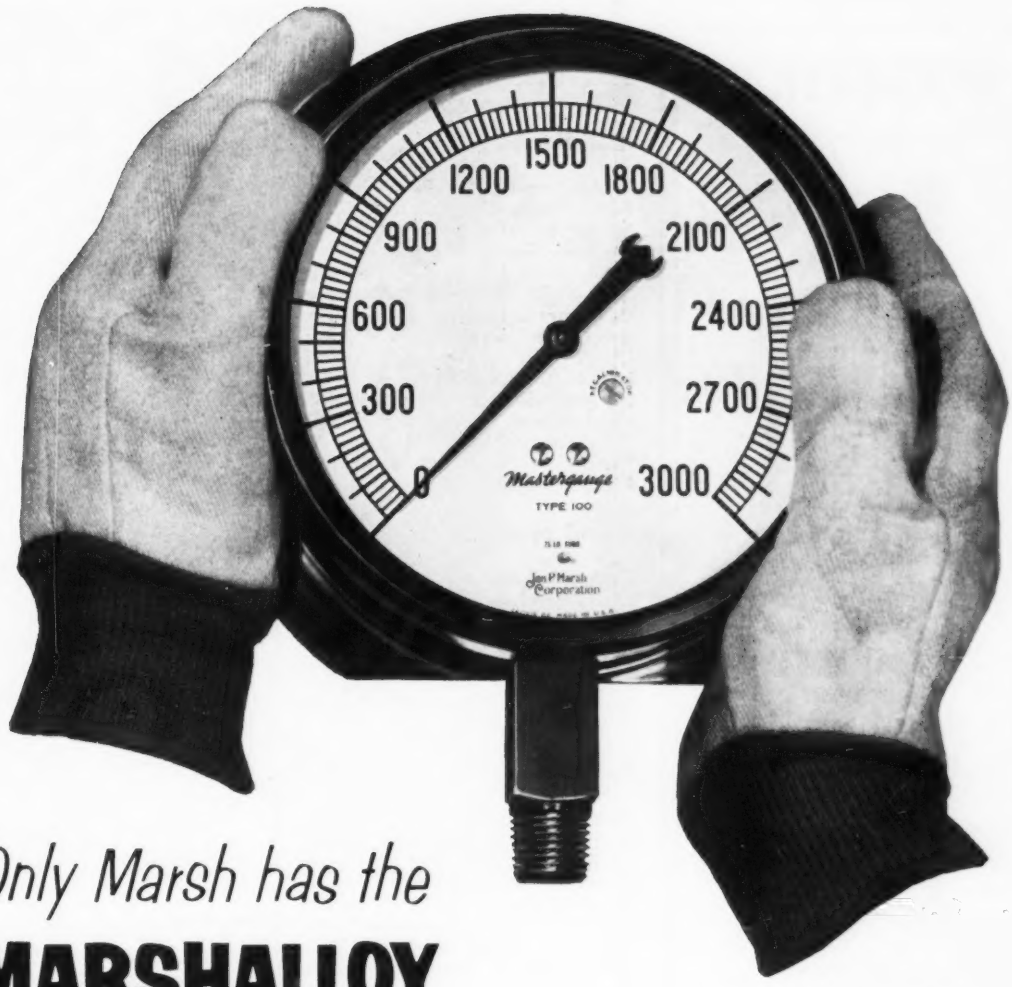
Worthington Corporation, Mason-Neilan division: A Blair Powell, general sales; E Putnam Head, Southeastern region; Warren F Priest, Eastern region; Alex M Thackara, West Coast region. **Horizons Incorporated:** Roger A McIntyre, director of sales. **Palmer-Shile Company:** Phillip A Kessler, Wisconsin office.

Allis - Chalmers Manufacturing Company: W E Korsan, electrical application department. **The Babcock & Wilcox Company,** Tubular Products division: J Y McCandless, Syracuse office. **Johnson Service Company:** Robert H Anderson, Youngstown branch. **Raybestos-Manhattan, Inc:** T W R Latham, Los Angeles district; Nevin L Rush, distributor sales, Philadelphia district; Julian P Chilcote, sales representative, New York.

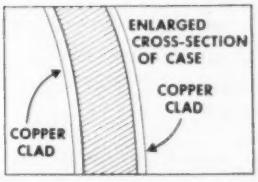
New district offices

Thermal Research & Engineering Corporation: at 3021 W 63rd St, Chicago, Ill. **Rockbestos Products Corporation:** at 4655 N Central Expressway, Dallas, Texas; and at 3127 Maple Drive, Atlanta, Ga. **Century Electric Company:** at 1238 NW Glisan St, Portland, Ore., Donald R Vick, manager.

(*Continued on page* 214)



Only Marsh has the **MARSHALLOY CASE**



The strength of steel; the corrosion resistance of solid copper . . . that's the Marshalloy copper-clad case.

Four times stronger than cast iron
One-third lighter

There's nothing temperamental about a pressure gauge . . . provided it's built right and given proper protection. The basic units of Marsh Gauges—socket, tube and movement—are known for the care given to their manufacture. Such units deserve the best protection . . . and *get it* in the Marshalloy case. Here is a steel case of boiler-plate-thickness, heavily clad with copper inside and out . . . lighter, but many times tougher . . . protected against the ravages of corrosion. It is available only in Marsh Gauges.

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Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
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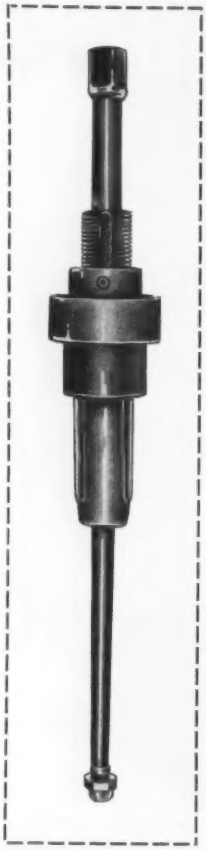

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AND REPLACEMENTS COMBINE ECONOMY WITH PERFORMANCE

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Whether you're installing new tubes or re-rolling old ones, Henderer's Tube Expanders and replacement parts offer top performance at lowest costs.

Henderer's "FC" Expanders are famous throughout the trade for top performance in general purpose use as well as automatic control devices; meet military specifications. Expanders also made to specification.

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A. L. HENDERER'S SONS
626 MARYLAND AVENUE
WILMINGTON 99, DELAWARE

Oldest Original Manufacturer Of Tube Expanders

More APPOINTMENTS

Begins on page 212

New distributors

For **Automatic Switch Company:** Leinart Engineering Company, 412 E 5th Ave, Knoxville 5, Tenn. For **Electro Steam Generator Corp:** The Paul B Huyette Co, Inc, 205 E 42nd St, New York 17, N. Y. For **Hills-McCanna Company:** Gulf Supply Company, Inc, with offices in Beaumont, Corpus Christi, Dallas and Houston, Texas, and in Lake Charles and Shreveport, La. For **Baker-Raulang Company:** Wilson Industrial Equipment, Inc, 6431 NW 32nd St, Miami, Fla.; 920 W Adams St, Jacksonville, Fla.; and 4709 E Hillsborough Ave, Tampa, Fla.

Recent purchases

Rockwell Manufacturing Company: acquisition of assets of Republic Flow Meters Company. **H K Porter Company Inc:** acquisition of R Thomas & Sons Company, Inc, and Federal Wire & Cable Company, Ltd. **York-Shipley, Inc:** purchase of furnace division of Jackson & Church Company.

Recent moves

Alco Products, Inc: Pittsburgh district office to Greentree and Cochran Rd, Scott Township. **Olin Mathieson Chemical Corporation,** Industrial Chemicals division: St. Louis district sales office to 8000 Bonhomme St, St. Louis 5, Mo. **Robertshaw-Fulton Controls Company:** Flexible Shaft division: to new and larger manufacturing plant in Chatham, N. J.

Institute elections

National Association of Corrosion Engineers: W H Stewart, president; L L Whiteneck, vice-president; Al Stegner, treasurer. **American Society of Lubrication Engineers:** J O McLean, president; J D Lykins, vice-president-at-large; J L Finkelman, secretary; J W Peterson, treasurer; T A Marshall, Canadian regional vice-president; R F McKibben, Central regional vice-president; M E Dougherty, Eastern regional vice-president; A B Wilder, Midwestern regional vice-president. **Society for Advancement of Management:** Homer E Lunken, president. **Battelle Memorial Institute:** Edward E Slowter, vice-president.

Awards

Harold A Peterson, professor and chairman of electrical engineering department, University of Wisconsin, awarded the annual Benjamin Smith Reynolds Award for excellence in the teaching of future engineers.

Dudley D Fuller, professor of mechanical engineering, Columbia Univer-

JUST OFF PRESS!

Nuclear Power Engineering

Gives a clear explanation of nuclear power plants—design, construction, and operation. From essential fundamentals of physics to detailed design features of specific power reactors, every important aspect is covered. In addition to engineering methods, the book includes helpful information on the components of various systems, radiation and its effects on equipment and health, plant sites, economics of nuclear power production, and other pertinent topics. **By H. C. Schwenk, Henry Pratt Co., and R. H. Shannon, United Engineers & Constructors, Inc. Ed. by B. G. A. Skrotzki, Mgt. Ed., Power. 344 pp., illus., $6.50**

Power Plant Management

Practical guide to effective management thinking in all aspects of producing dependable power at lowest cost. Covers a wide range of topics, from purchasing and use of equipment, and its safe and efficient operation, to hiring, training, and supervision of operators. Shows how objectives, costs, and equipment characteristics should be correlated and evaluated to determine best course of action. Gives yardsticks for measuring effectiveness of management and supervisory performance. **By R. H. Emerick, Consulting Engr., 339 pp., 6x9, 74 illus., $6.50**

Plant Operators' Manual

Shows engineers, firemen, oilers, and mechanics, how to maintain and operate their equipment. Gives methods and pointers to help not only in daily work but also in future upgrading and license examinations. Progressive photos, drawings, and diagrams take you step by step through each job on boilers, engines, turbines, pumps, compressors, and similar equipment. Practical help on jobs ranging from how to start a diesel engine to winding springs. **By Steve Elonka, Assoc. Ed., Power. 292 pp., 1539 illus., $5.00**

PROFESSIONAL ENGINEER'S EXAMINATION QUESTIONS AND ANSWERS

Over 500 questions and complete answers to help engineers pass state license examinations. Covers mechanical, electrical, civil, and chemical engineering, and includes engineering economics and land surveying. Latest questions—suitable for all states. Author has worked on New Jersey examination preparation for 19 years. By William S. LaLonde, Jr., 462 pp., 234 illus., $6.50.

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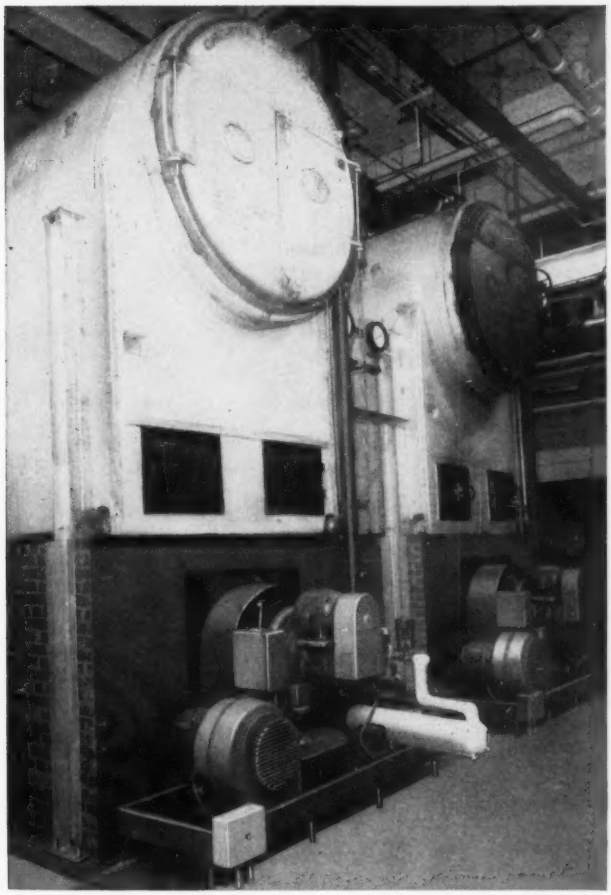
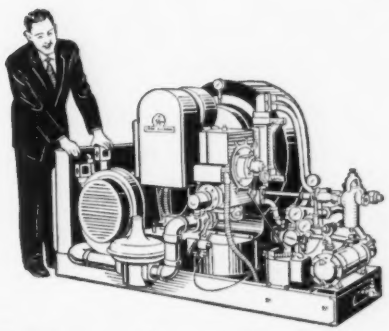


Iron Fireman packaged oil firing units applied to firebox boilers. These units are suitable for nearly all types of steam or hot water boilers. The heating plant shown above is in the office building of the Celanese Corporation of America, Charlotte, N. C.

A complete firing system by Iron Fireman



Engineered as a unit . . .
installed as a unit

For oil, gas or oil-gas combination

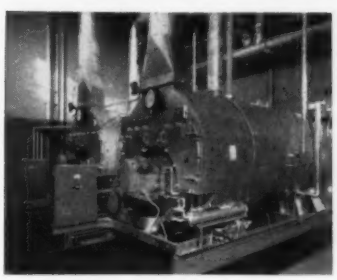
Here is a *factory engineered* firing system. Everything needed for balanced firing is mounted on a rigid steel base, ready to bolt to the boiler front. Nothing is left to the uncertainties of local assembly. For example, the critical refractory firing throat is pre-cast and installed at the factory, rather than being molded on the job. It is critical because proper design and accurate placement of the refractory tile increases combustion efficiency. It is scientifically designed to introduce secondary air around the burner head, avoiding the elaborate firebox brickwork in the typical conversion job.

Accurate control of all firing functions Every factor that affects firing efficiency is engineered into the unit at the factory. The unit includes: (1) Single or dual-fuel burner, with complete fuel handling systems. (2) Forced draft air supply. (3) Enclosed control panel, with instruments mounted, factory wired and tested, and with signal lights and dials that afford a complete reading at a glance.

In the oil-gas units, fuels can be switched automatically, or with the simple flick of a switch. Fires any fuel gas or any commercial grade of fuel oil available, including No. 6, without changing burner adjustment.

Local service. Hundreds of dependable Iron Fireman dealers are located in all parts of the United States and Canada. Their factory trained personnel are ready to furnish quick service to your burner, should the need arise. In addition, factory engineers are available in most areas to help you and your consulting engineer in planning boiler room modernization or construction.

For further information, mail coupon.



With matched Scotch type boiler

America's top boiler manufacturers join with Iron Fireman to produce boiler-burner units in which the boiler and firing system are engineered as a single integrated unit. Hundreds of these installations are in use in all parts of the world, with outstanding performance records. The boiler room, shown above, equipped with Iron Fireman-Kewanee units, is in one of the Detroit plants of the Briggs Manufacturing Company.

Iron Fireman®

AUTOMATIC FIRING EQUIPMENT FOR OIL, GAS, COAL

IRON FIERMAN MANUFACTURING CO.
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Please send information on Iron Fireman forced draft firing for oil, gas, or oil-gas combination.

Name_____
Firm_____
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City_____ State_____

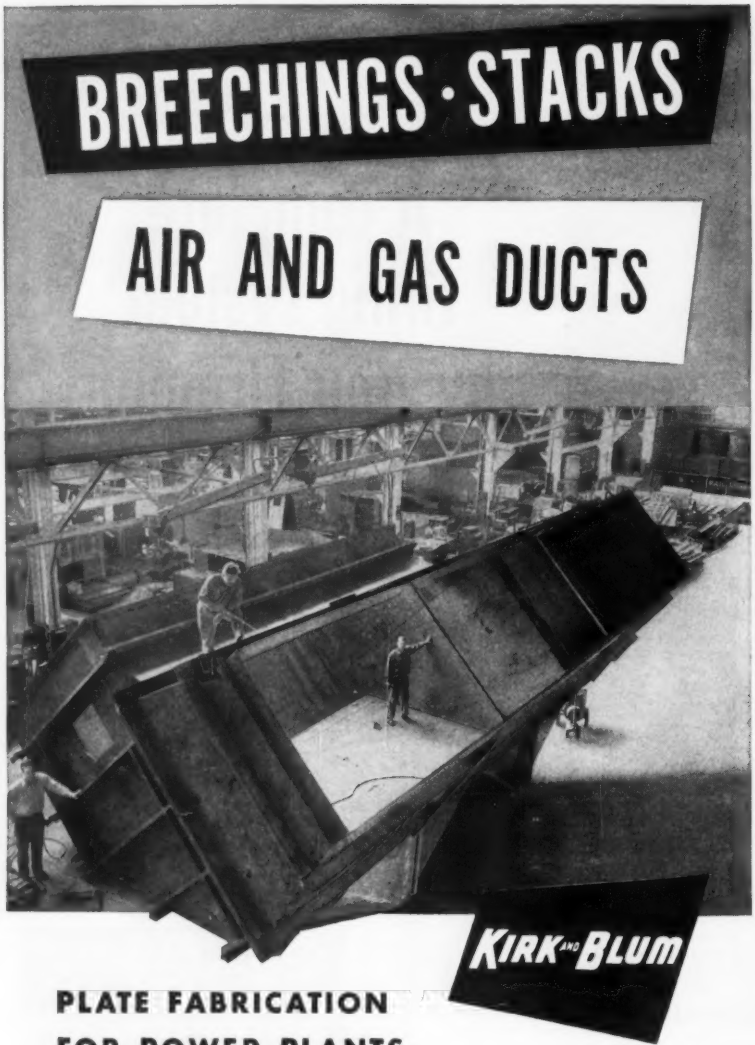

PLATE FABRICATION FOR POWER PLANTS

Whatever your requirements in fabricated plate, sheet or structurals for power plant use . . . call on experts!

Kirk & Blum has fabricated a variety of power plant needs as big as the mammoth breeching section shown here. In a 150,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, pre-assemble and load the largest fabrication. Kirk & Blum has the men, materials and experience to do the job quickly and economically.

For detailed literature, write: The Kirk & Blum Mfg. Co. 3233 Forrer St., Cincinnati 9, Ohio

KIRK & BLUM
FABRICATION

More APPOINTMENTS

Begins on page 212

sity and principal scientist at Franklin Institute of the State of Pennsylvania, received the ASLE National Award for his ". . . conspicuous service to the science of lubrication . . . through research, educational leadership and contributions to the literature."

Obituaries

Charles C Cheyney, vice-president of sales for Buffalo Forge Company, on April 25th.

Vsevolod Nicholas Stankoff, 72, chief engineer, department of compression ignition engines in Washington office of Barnes & Reinecke, Inc, on April 29th.

Wilbur S Holton, 52, vice-president of Orangeburg Manufacturing Co, Inc, on April 20th.

John C Rector, sales manager of Industrial Insulation division, The Philip Carey Mfg Company, on April 22nd.

REPORTS from the FIELD

Begins on page 146

Beat the heat

continued

best commercial dielectric ceramics. It can be made opaque or it can be transparent, the first polycrystalline material ever to exhibit this optical property.

Experimental *Pyroceram* compositions have flexural strengths as high as 60,000 psi. The strength-to-weight ratio of one *Pyroceram* is identical to that of annealed aluminum, greater than that of titanium and stainless steel.

Another boon to the design engineer is the material's great flexibility in forming. It can be made into large or complex shapes by any of the known glass-forming techniques. It is said to be adptable to mass production, and can be pressed, drawn, blown, rolled and centrifugally cast.

Calendar of Events

July 28-Aug 9—Department of Industrial Management Engineering of Columbia University, 6th Utility Management Workshop. Arden House, Harriman, N. Y. Details from Mrs Rae Wygant, 409 Engineering, Columbia University, New York, N. Y.

Oct 1-4—National Association of Corrosion Engineers, exhibitions and meetings of North Central Region and South

Fuel cost survey proves coal best for Poinsett Hotel

The Poinsett Hotel, Greenville, S.C., recently decided to increase steam capacity by adding a new boiler in its power plant. At the time, management asked its consultants, The McPherson Company, of Greenville, to analyze costs of all three types of fuel available in that area. On the basis of cost per thousand pounds of steam, the other two fuels proved to cost 25% more than bituminous coal. According to The McPherson Company, "The net result of this study indicated that by continuing with the use of bituminous coal the owners would save on both the initial investment and on operating costs."

For additional case histories on burning coal the modern way or for technical advisory service, write to the address below.

BITUMINOUS COAL INSTITUTE
Southern Building • Washington 5, D. C.

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum • Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

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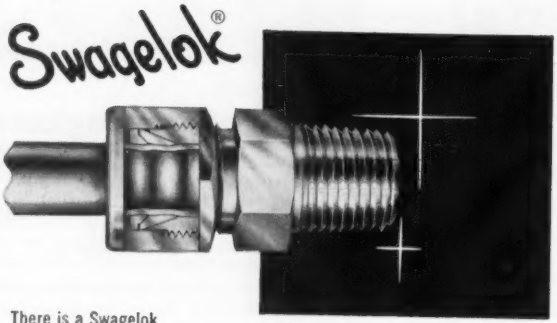

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REPORTS from the FIELD

Begins on page 146

Central Region. Exhibition and technical sessions, North Central Region: Sherman Hotel, Chicago; South Central Region: City Auditorium, Oklahoma City, Oklahome. Details from NACE, 1061 M&M Bldg, Houston 2, Texas.

Oct 6-8—Fluid Controls Institute, Westchester Country Club, Rye, N. Y. Details from Air Conditioning and Refrigeration Institute, 1346 Connecticut Ave, N.W., Washington 6, D.C.

Oct 9-11—Committee on Vacuum Techniques, 4th Annual Symposium Of High Vacuum Technology. Hotel Somerset, Boston, Mass. Details from CVT, Box 1282, Boston 9, Mass.

Oct 14-16—Industrial Sanitation Management Association, 2nd Annual Sanitation Maintenance Show and Conference. Navy Pier, Chicago, Ill. Details from International Sanitation Maintenance Show and Conference, 19 W 44th St, New York 36, N. Y.

Oct 14-18 — International Industrial Development Conference, co-sponsors: Time-Life International and Stanford Research Institute. Fairmont Hotel, San Francisco, Calif. Details from Stanford Research Institute, Menlo Park, Calif.

Oct 21-23—American Society of Mechanical Engineers, conference on new developments in the field of power. Americus Hotel, Allentown, Pa. Details from ASME, 29 W 39th St, New York 18, N. Y.

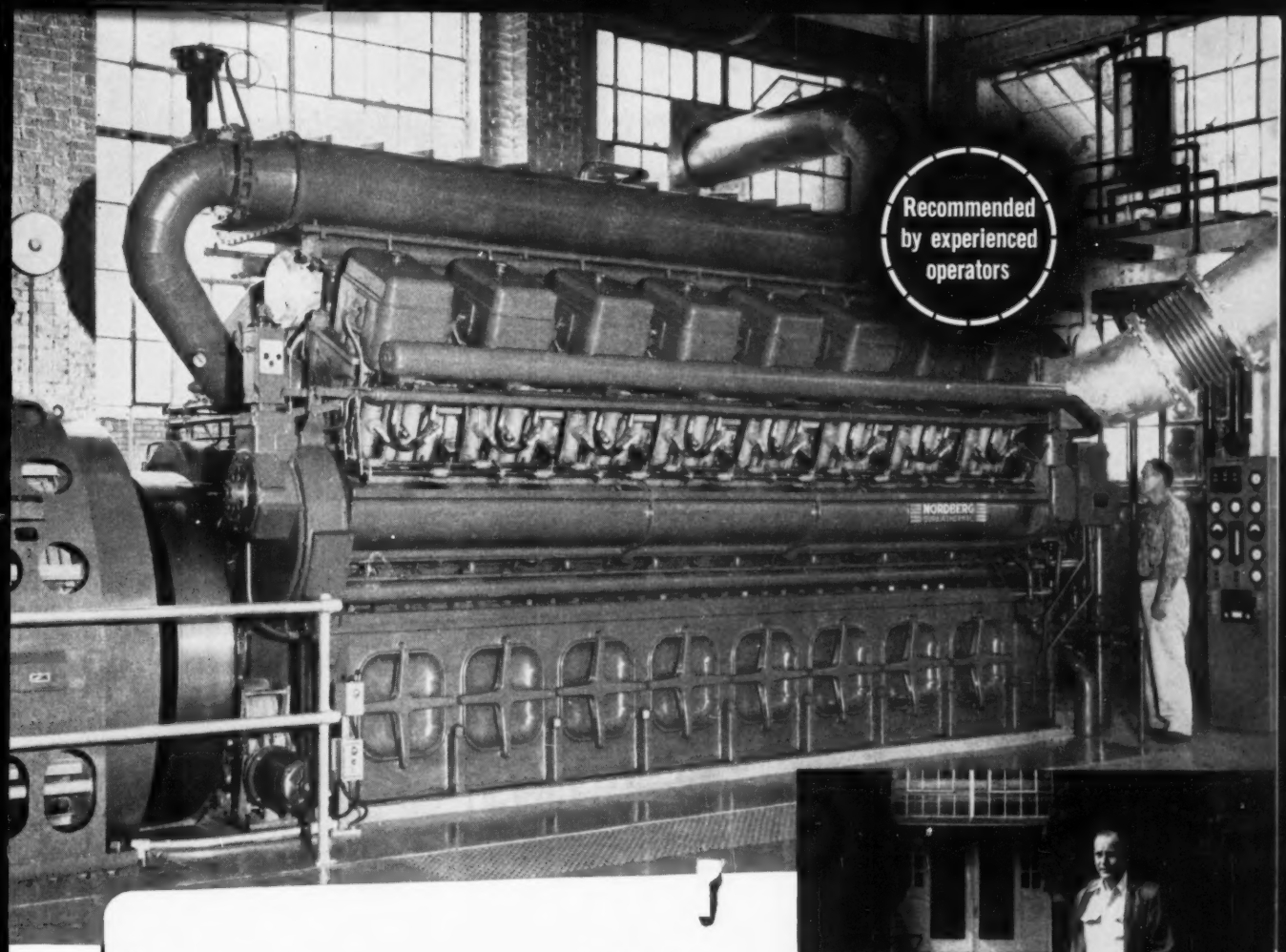
Oct 22-24—National Association of Corrosion Engineers, 7th Annual Western Regional Conference. San Diego, Calif. Details from National Association of Corrosion Engineers, 1061 M & M Bldg, Houston 2, Texas.

New Zealand produces power from geothermal steam

NEW ZEALAND (MCGRAW-HILL WORLD NEWS) . . . Geysers, hot springs, boiling mud and steam vents have long been a mecca for tourists in New Zealand's North Island. Today, part of this thermal wonderland is being turned to more important practical use—the production of electric power.

The potential geothermal power output from the project at Wairakei is 250,000 kw—perhaps greater than this if more positive evidence is obtained that the necessary steam and hot water is available. Reporting to the government, London consulting agents recommend extension of the plant in 3 stages to reach maximum production.

Stage I, already under way and due to be producing power late next year,



"Neodesha has now installed their sixth Nordberg engine ...all are giving a good account of themselves..."

...says Mr. Everett Powell,
Superintendent,
City of Neodesha, Kansas

Mr. Powell writes: "*The City of Neodesha has now installed their sixth Nordberg engine since 1922—all are giving a good account of themselves. Our newest, a 3150 B.H.P. Nordberg V-16 Supairthermal Duafuel unit, has been operating very satisfactory and we expect the same excellent service as recorded by our prior installed 1750 B.H.P. Duafuel unit. Our recent overhaul on this 1750 B.H.P. unit showed that rings and bearings still did not need replacement after 40,000 hours.*"

Here, then, are more reasons why Nordberg engines are recommended by experienced power plant operators . . . more reasons why there are so many *repeat* orders for Nordberg Diesel, Duafuel®, and Spark-Ignition Gas engines. Next time consult Nordberg on your power study . . . builders of a full range of engine sizes from 600 to over 12,000 hp. *NORDBERG MFG. CO., Milwaukee, Wisconsin.*

Installation Data:

1922—Installed 2 Nordberg 550 hp engines in Neodesha plant.

1934—Installed Nordberg 880 hp engine.

1946—Installed Nordberg 1620 hp engine.

1952—Installed Nordberg 1750 hp engine.

1956—Installed sixth Nordberg engine . . . a 16-cylinder V-type Supairthermal® Duafuel engine rated 3150 bhp, 2250 kw.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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P757

18

for
BIGELOW ★
BADENHAUSEN ★
CASEY HEDGES ★
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and others

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REPORTS from the FIELD

Begins on page 146

will provide 69,000 kw. According to the engineers, enough steam and some to spare has already been won to feed this plant. Stage II would provide another 82,400 kw—possibly by next year also, if the rate of steam winning is kept up. Stage III would provide a further 101,200 kw, giving a total generating capacity of 252,600 kw. The engineers say that present expectations justify the planning of this third stage; but since it would require the conversion of hot water from the bores into steam, they recommend a delay until Stage I has been in operation and knowledge gained from the use of a pilot plant to produce steam from the water.

Belgium to have atomic power by 1959

► SOCIETE COOPERATIVE ELECTRO Nucleaire has announced, in Brussels, the signing of a formal contract with Westinghouse Electric International Co, New York, for an 11,500-kw atomic power plant which will provide Belgium with electrical energy by the end of 1959.

The agreement is the first firm and complete contract for the export of an atomic power unit. Belgium and the U.S. have signed a bilateral agreement covering the exchange of information, materials and equipment for atomic power.

As much of the electrical apparatus for the plant as possible will be manufactured by Belgian industry, Electro Nucleaire announced.

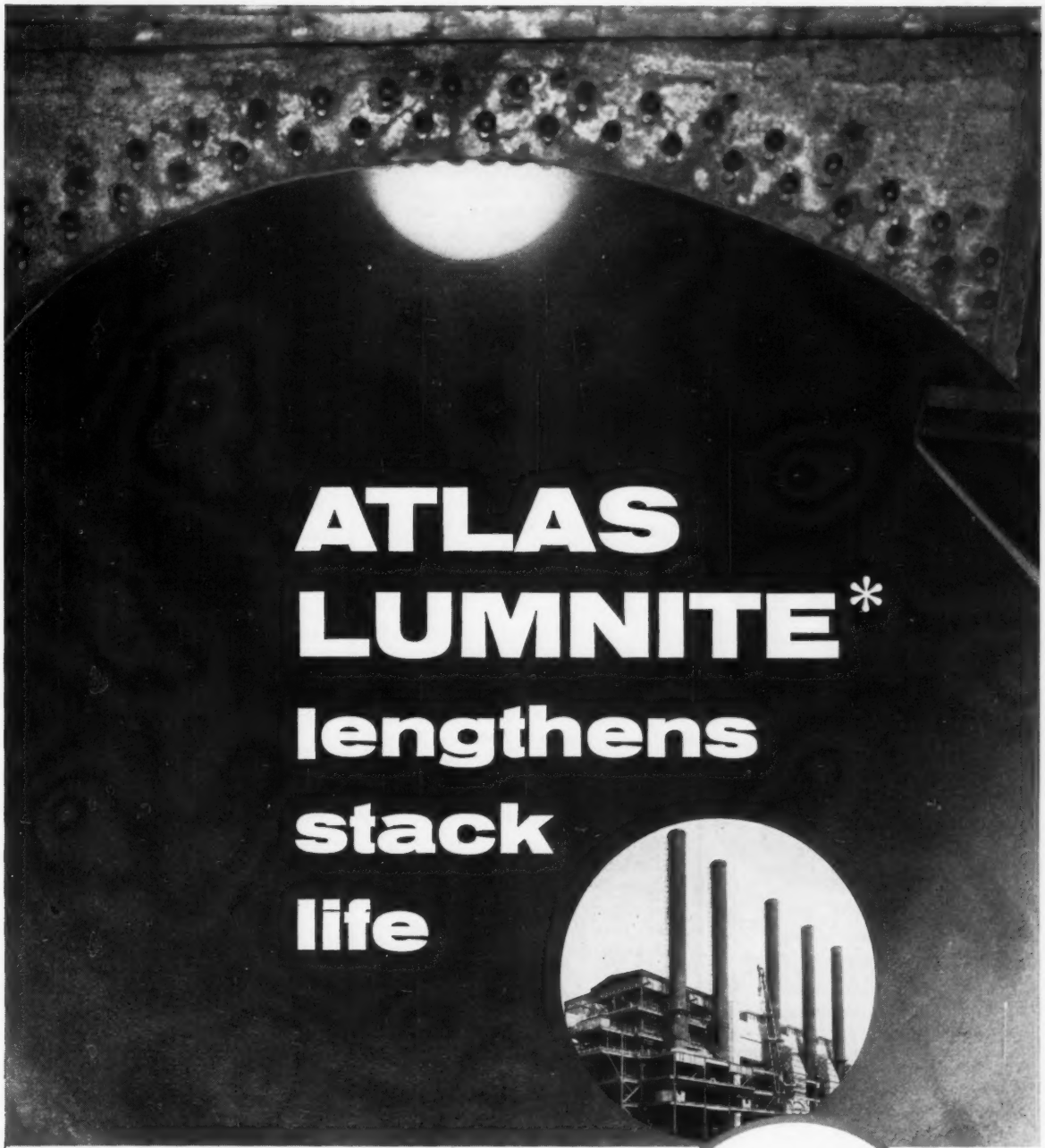
Power generated by the plant will be delivered to the grid or electrical transmission system that serves the entire country. The plant will serve as a prototype for future development of atomic electric power.

The Westinghouse unit will embody the latest advances in pressurized water reactor design and will utilize slightly enriched uranium oxide as fuel, the Belgium enterprise revealed. It will be installed near Brussels at Mol, center for the company's atomic research.

A.G.E.'s Wabash plant saves 50% space

► EFFICIENCIES IN THE DESIGN of the Indiana and Michigan Electric Co's new plant on the Wabash River, make possible space saving of almost 50%.

Only 5,350,000 cu ft of space will be required for the 450,000-kw unit



GUNITED STACKS AND BREECHINGS at Linden, N. J., generating station of Public Service Electric and Gas Co. (Newark) are among the growing number of power-plant installations using concrete linings made with Lumnite cement. From ash hoppers to stacks, Lumnite linings reduce maintenance costs and provide long service life.

- Lumnite-made industrial concretes give rugged resistance to heat, corrosion, abrasion and thermal shock.
- Placement is fast and easy—by guniting, pouring or plastering.
- Downtime is reduced to a minimum—service strength is reached within 24 hours.

For maximum convenience, use Lumnite-made castables. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For more information, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

UNIVERSAL ATLAS CEMENTS

USS

* **"LUMNITE"** *is the registered trademark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

L-154

UNIVERSAL ATLAS CEMENT COMPANY—member of the industrial family that serves the nation—**UNITED STATES STEEL**

OFFICES: *Albany • Birmingham • Boston • Chicago • Dayton • Kansas City • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • St. Louis • Waco*

McDonnell goes High Pressure

No. 92 Series Pump Control, Cut-off and Alarm Switch
For pressures to 250 psi.

- Repulsion magnetic switching—for positive opening *and* closing.
- Unprecedented heat dissipation—okayed for 75° C. (167° F.) wiring at terminals.
- Extra generous clearances in float chamber.
- Operating levels unaffected by pressure changes.
- McDonnell quality throughout.
- Four models—with or without integral water column.

Use this new 92 Series for controlling boiler feed pump, or electric valves; for low water cut-off or alarm; for tank level control, etc. For lower pressures—to 150 psi.—use companion 91 Series. New catalog has full engineering data.

Write for Bulletin L-123

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave. • Chicago 18, Ill.
Doing One Thing Well

McDONNELL
Boiler Water Level Control

REPORTS from the FIELD

Begins on page 146

and its related facilities, against 8,666,000 cu ft for two of the more conventional 225,000-kw units.

Reinforced, poured concrete stack will be 577 ft above ground level, while the outdoor boiler will be as tall as a 23-story building and will consume 1,300,000 tons of coal a year. Turbine room will measure 128 by 148 ft and will be 72 ft high, while the office building will be 84 by 179 ft and 29 ft high. General Electric Co will manufacture the generating equipment. The finished plant will cost $58 million.

Realistic solution asked for Argentine power lack

BUENOS AIRES (MCGRAW-HILL WORLD NEWS) . . . Argentina's business community has raised its voice—finally—to demand some realistic solution to Buenos Aires' power shortage which is crippling industry here.

A note to provisional President Pedro E Aramburu signed jointly by the three foremost industrial and agricultural associations of the country pointed out that current power cuts are resulting in a 9% decrease in industrial activity in the area of the Argentine capital and costing more than 30,000 million pesos a year (about 1,667 million dollars at the official 18 to 1 exchange rate) in lost production.

The letter was intended to counteract strong political pressure from the powerful nationalist-socialist-radical groups which have been pressing for complete nationalization of the country's overburdened power facilities.

It made no concessions to political expediency (for many years it has been regarded as an essential part of political know-how in Argentina to go along, at least tacitly, with the idea of nationalizing public utilities.)

"You know why you don't get ahead, George? You don't show enough interest in your work."

protect YOUR INVESTMENT

with a
TIME TESTED LINE OF LUBRICANTS . .

ALBANY LUBRICANTS

PAST PERFORMANCE IS YOUR ASSURANCE OF FUTURE SATISFACTION

ALBANY PRESSUREGREASE UNIVERSAL
For Cups — Ball Bearings — Water Pumps — Universal Joints. Waterproof — Exceptionally high melting point. Soft enough for gun application.

ALBANY GREASE
A cooling lubricant in 3 consistencies for operating temperatures from 110° F to 200° F.

ALBANY PRESSUREGREASE
A superior waterproof mineral oil grease of high viscosity. Comes in Liquid, Soft, Medium, Hard and Graphite. Pressuregrease Soft and Medium.

ALBANY BEARING LUBRICANT
(Ball or Roller Bearing)
Will not separate or oxidize assuring long life to bearings. May be used in hand grease guns.

ALBANY GEAR LUBRICANTS
Retard wear, quiet gears. Waterproof. Will not drip when gears are idle or in motion.

ALBANY PENETRATING OILS
(Clear or Graphite)
Quick-acting. Cut rust as well as lubricate. Loosen sticky valves, eliminate squeaks.

Order Albany Lubricants through your supply house.

Serving industry throughout the world since 1868.

ADAM COOK'S SONS, INC.
Mfrs. of Albany Lubricating Products
LINDEN, NEW JERSEY

For Fly Ash Collection...

Western Precipitation
presents
its latest development
in a quarter-century of
continuous advancement
in Mechanical Collectors

...The "9VGR" MULTICLONE!

Over 25 years ago

Western Precipitation Corporation pioneered the high-efficiency multiple-tube principle that has proven so superior it is now the pattern for the industry.

The Multiclone continues to be years *ahead* of all other centrifugal collectors because it incorporates the invaluable "know-how" gained through these many years of leadership in the field —leadership that is further emphasized by introduction of the 9VGR Multiclone, another important milestone in Multiclone's quarter-century of outstanding performance.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

NEW 9VGR FEATURES...

1. *No need for continuous external support.*
2. *Easier and less costly to insulate.*
3. *Minimum dust stratification.*
4. *Improved dust distribution to all tubes.*
5. *Simpler installation, lower erection costs.*
6. *Freedom from leakage at all critical points so that full collection efficiency is obtained.*

Plus **The proven superiority of CAST IRON TUBES and VANES!**

Through the years, others have tried special alloy steels and so-called "miracle" metals, but nothing has proven as satisfactory *in actual field service* as cast iron. In the past quarter-century more than 270,000 Multiclone tubes have been placed in service with less than 1.85% replacement—*a performance record unequalled in the industry!*

There are many other advantages built into the 9VGR. There is a Multiclone representative near you who will be glad to supply complete details. Or write direct, asking for your free copy of Bulletin #M209 which contains full details.

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases ... and Equipment for the Process Industries

Main Offices: **1049 WEST NINTH STREET, LOS ANGELES 54, CALIFORNIA**

Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building, Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4
Precipitation Company of Canada Ltd., Dominion Square Building, Montreal
Representatives in all principal cities

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line* of hub spline faces (the load-carrying surfaces) . . . no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

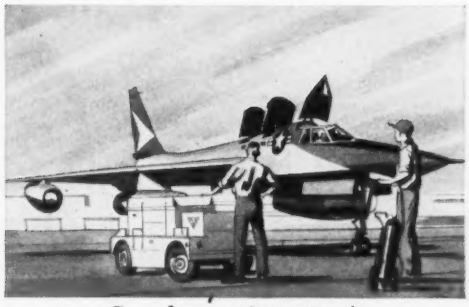
For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3307, Scott Street, Baltimore 3, Maryland.

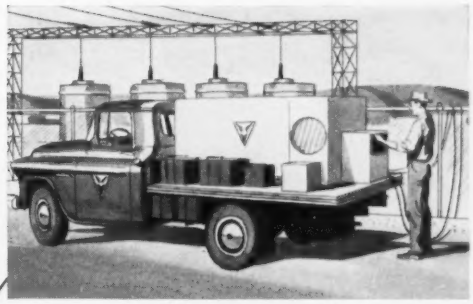
THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
Engineered Products Sold with Service.

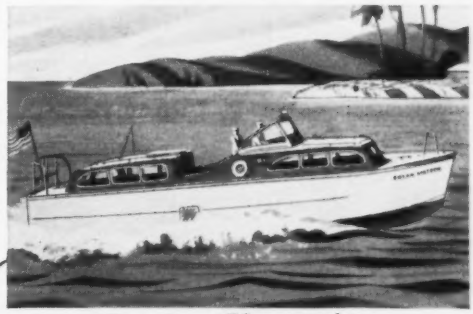


Ground support for jet aircraft.

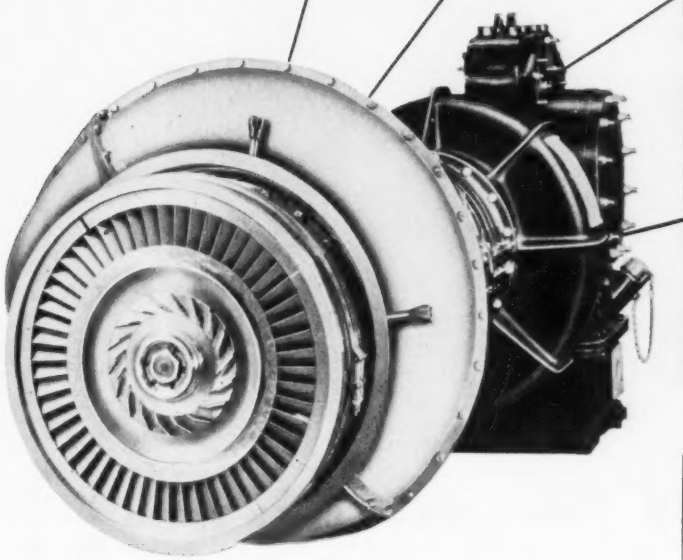


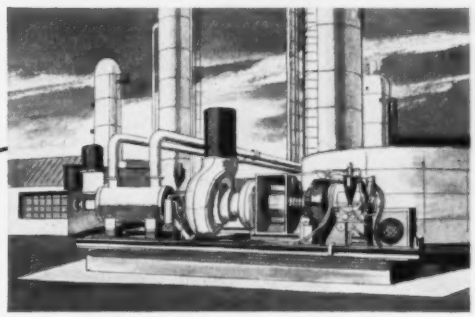
Portable power generation.

Jupiter® finds new uses!



Power for small boat propulsion.





Turbine drives for gas compressors.

ENGINEERS WANTED Unlimited opportunities, challenging projects, good living with Solar! Write for new brochure.

New gas turbine engine proves its versatility

JUPITER GAS TURBINES provide reliable power for a wide range of military and industrial uses. Simple and rugged, compact and lightweight, the 500 hp Jupiter offers many advantages over conventional power plants. New users praise its high power-to-weight ratio, its instant starting even under severe temperature extremes, its easy portability and low maintenance requirements. Experience has proven the effectiveness of Jupiter gas turbines for power generation, boat propulsion, mechanical drive and still other applications. Perhaps this versatile engine can help solve your special power problems. Write for new Solar gas turbine brochure... Dept. D-49, Solar Aircraft Company, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY

SAN DIEGO
DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS – GAS TURBINES • AIRCRAFT AND MISSILE COMPONENTS • BELLOWS • CONTROLS • COATINGS • METAL ALLOY PRODUCTS

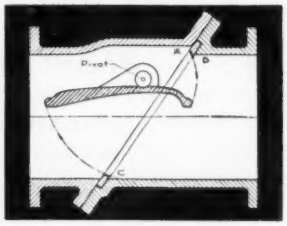
You have to see it to believe it . . .

(You Can't Hear It!)

CHAPMAN Tilting Disc Check Valve

It's the silent valve. No noise, no vibration, no fluttering. On usual piping arrangements you get no slamming with a Chapman Tilting Disc Check Valve. You get no banging to cause damage to system or valve . . . no grinding, scraping or wearing of either the disc or seat. Your maintenance costs go down to an unbelievable low which is really something to see and enjoy.

You can safely use these valves under tough operating conditions. You can order them in iron and steel . . . for handling fluids or gases under a wide range of pressures. You can get them fast. See our Catalog 30-A. Write for your copy today.

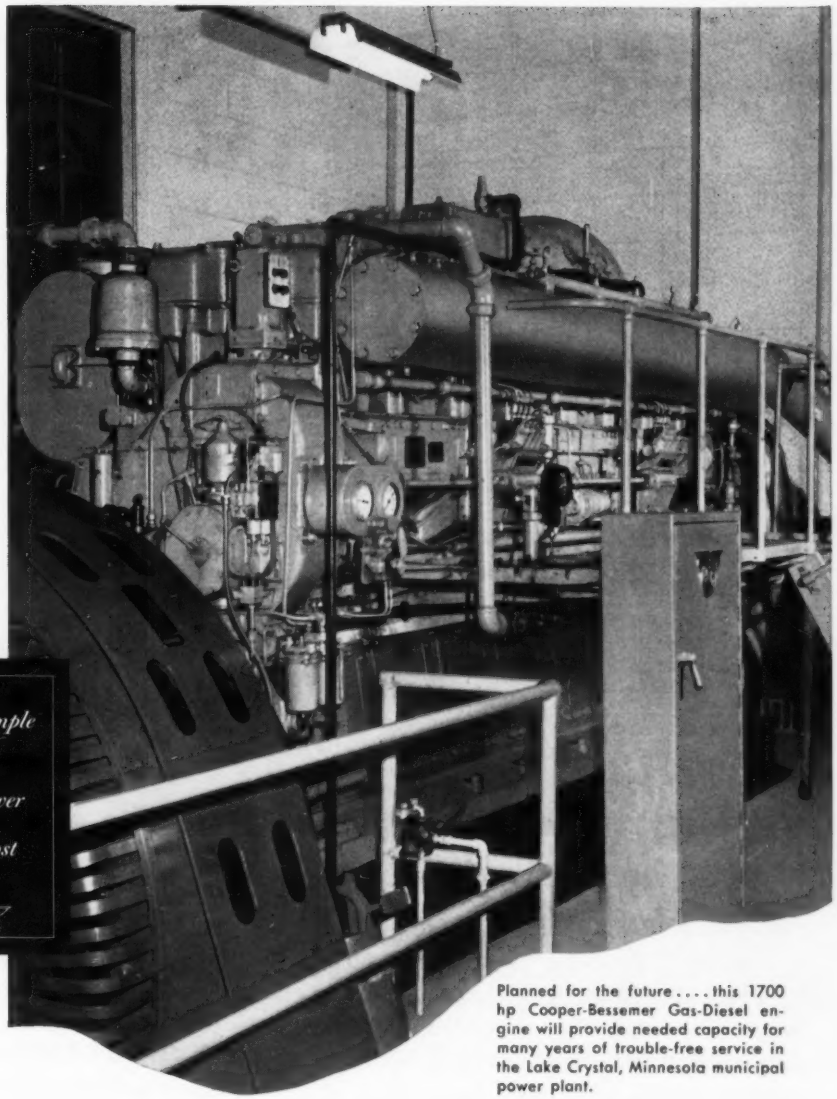


Look at this operational chart. When the flow is on, "airfoil" disc is held firmly against stops in the body. When the flow drops, disc balances quietly on whatever flow there is. When flow stops, disc drops quickly, quietly and firmly on special bevel seat. Note that sufficient space is designed around disc to cut down flow resistance.

THE CHAPMAN VALVE MANUFACTURING CO.
INDIAN ORCHARD, MASSACHUSETTS

Why this small municipal plant bought extra engine output

Another Example of Efficient Power at Lower Cost



Planned for the future . . . . this 1700 hp Cooper-Bessemer Gas-Diesel engine will provide needed capacity for many years of trouble-free service in the Lake Crystal, Minnesota municipal power plant.

● Lake Crystal, Minnesota carefully studied the matter, installed a high output Cooper-Bessemer engine, and they're far from sorry. This small community enjoys substantial savings from a 1200 kw. . . . 1700 hp. . . . 155 bmep Gas-Diesel engine.

The engine, a supercharged Cooper-Bessemer JS, boasts an enviable "around the clock" operational record with excellent fuel economy maintained under heavy *or* light loads. With the installation of this new unit, there's no further need for riding an engine at costly, inefficient loading in anticipation of sudden heavy increases.

Although oversized for present needs, this 8 cylinder Cooper-Bessemer will more than justify its original cost. Dependable, economical power will be available for many future years. And as Lake Crystal power demands grow . . . this JS will easily handle the increased load. No need for costly plant expansions. No new engines to buy.

Impressive month by month operating cost records of Lake Crystal municipal are available upon request. Write The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

MOUNT VERNON, OHIO

COOPER-BESSEMER

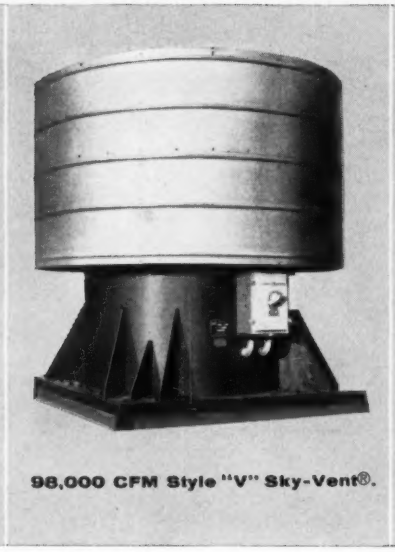
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Chicago, Ill. • Houston, Dallas, Greggton, Pampa and Odessa, Texas • Washington, D. C. Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. Caracas, Venezuela • COOPER-BESSEMER OF CANADA, LTD., Edmonton and Calgary, Alberta, Canada.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

THREE PRACTICAL WAYS

84" 100,000 CFM Style "H" Sky-Vent®—one of four on power plant.



98,000 CFM Style "V" Sky-Vent®.

Combination Package—Winter Makeup Air Supply and Summer Exhaust.

TO VENTILATE AND/OR HEAT A BOILER ROOM –

"BUFFALO" PACKAGE ROOF VENTILATORS — "Buffalo" Sky-Vent® Power Roof Ventilators provide efficient, high-volume exhaust of large room areas. They take advantage of heat rise and require no ductwork. Complete, ready-to-install units with inlet, curb plate, stack and hood — rigid, sturdy and weatherproof. Write for Bulletin FM-2345.

FOR MAKEUP AIR — where fresh, heated air is needed to replace large quantities of air removed from the boiler room by the forced draft fans, "Buffalo" Propeller Fan Makeup Air Package Units offer an economical solution. These consist of non-freeze finned steam coils and high-capacity propeller fans in easy-to-install units — available, too, with filtered intake and by-pass dampers for economical summer cooling. Write for recommendations on your requirements.

"BUFFALO" PACKAGE PROPELLER FANS — These are heavy-duty units, delivered ready to mount in window or wall openings and start exhausting excess heat against pressures up to 1". Their high-efficiency 4-blade design permits slow-speed operation for low noise level and long life. In 24" to 120" sizes to give you capacities clear up to 250,000 cfm, "Buffalo" Package Propeller Fans are proving the most satisfactory answer for ventilating many large boiler rooms, both from the economy and the performance standpoints. Have us mail you Bulletin FM-2345.

The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY

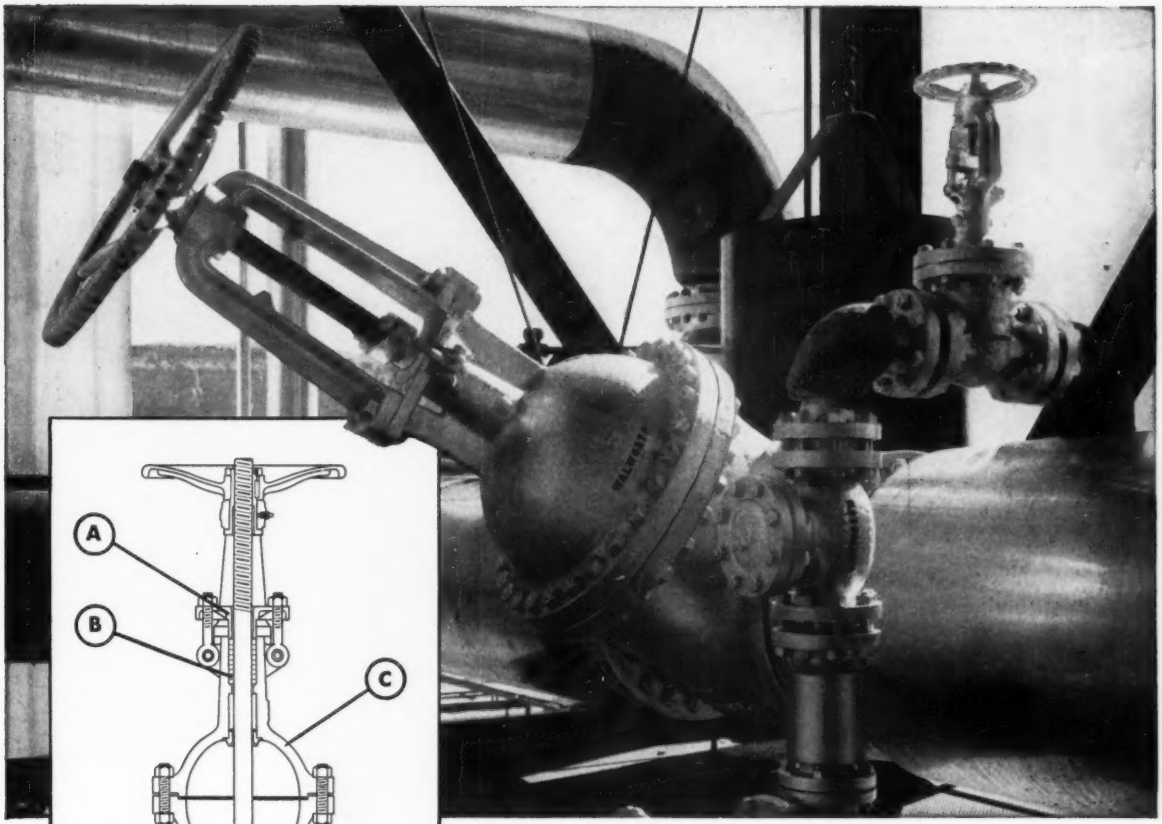
488 BROADWAY BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

"Buffalo"

INDUSTRIAL EXHAUSTERS BELTED VENT SETS PROPELLER FANS "E" BLOWERS – EXHAUSTERS



Walworth Series 150 and 300

CAST STEEL GATE VALVES OFFER YOU THESE FEATURES

for 'round-the-plant service

(A) GLANDS: Clearances between the gland and stuffing box, and gland and stem, are such that the stem cannot be scored even if the gland is pulled down unevenly.

(B) DEEP STUFFING BOXES: More than adequate in all sizes (2″ to 24″) to assure tightness and maximum packing life.

(C) BONNETS AND BODIES: Engineered to exceed the requirements of all applicable codes and standards. They are tough, durable, dependable.

(D) INTEGRAL GUIDE RIB FACES IN BODY: Machined to insure accurate centering of the gate.

(E) STURDY SEAT RINGS: Bottom-seated so that no recess exists at the back of the ring to cause turbulence, erosion and pressure drop.

(F) STREAMLINED PORTS: Permit unobstructed flow which results in minimum pressure drop and reduces the possibility of erosion.

Walworth Cast Steel Gate Valves can be furnished with either flanged ends or butt welding ends. Roller bearing yokes are available on the larger sizes. On valves 4 inches and larger, by-passes can be furnished. Walworth Cast Steel Gate, Globe and Check Valves from Series 150 to 2500, are available. For Series 600 and higher, we recommend Walworth Pressure Seal Cast Steel Valves. See your Walworth Distributor or write to Walworth for complete information.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION GROVE VALVE & REGULATOR CO.
SW SOUTHWEST FABRICATING & WELDING CO., INC. MH M & H VALVE & FITTINGS CO. WALWORTH COMPANY OF CANADA, LTD.

why wonder?

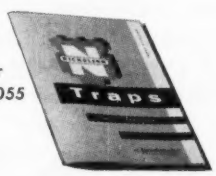
You can be sure you're getting a ready-to-go steam trap when you buy a Nicholson . . . because each and every one is tested in actual steam service before shipment.

And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous operation of your steam-using equipment . . . no downtime from trap failure.

- **high air-venting capacity . . . for faster warmup of equipment.**
- **powerful valve action . . . no mechanical linkages to cause trouble.**
- **small and lightweight . . . easy to pipe and support.**

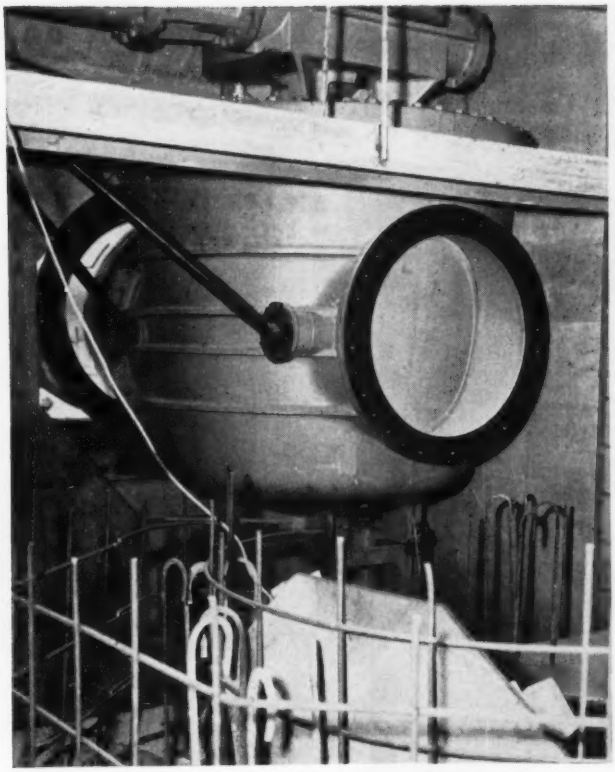
So, to get a trap that's service-tested, and loaded with operating features, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA., *Sales and Engineering offices in 98 principal cities.*

Write for Bulletin 1055



NICHOLSON

of Wilkes-Barre



Downhill view from Iron Mountain tunnel inlet shows first two conduits and pumping station, with reservoir and aqueduct in background. Excavation at right of pumping station will house third set of pumps, and third conduit will be added.

This SMS-Rotovalve at Iron Mountain shows clearly the drop-tight shut-off position. In operation, the conical plug first lifts, then turns, finally reseats, giving you precise aperture control.

3 MORE SMS-ROTOVALVES ORDERED FOR PUMP DISCHARGE SERVICE AT IRON MOUNTAIN

As part of the expansion program for increasing the supply of water to southern California through the Colorado River aqueduct, three more SMS-Rotovalves have been ordered by the Metropolitan Water District of Southern California. These three 48″ x 64¼″ tapered Rotovalves, duplicates of six already installed at Iron Mountain Pumping Station, will be used for pump discharge service. Their inherent characteristics of a large reduction of flow area during the early part of the closing stroke make them ideally suited to control of surges in the event of emergency shut-off.

SMS-Rotovalves give the least possible pressure loss. In the open position, their full line opening offers no more resistance than a straight piece of pipe of the same diameter. Hydraulic unbalance and mechanical design make operation easy, and less powerful operators may be used. Rotovalves' flexibility suits them to any type of operation, any method of control, or any sort of location.

To obtain information on SMS-Rotovalves, as well as on the entire SMS line of Butterfly and Ball Valves, contact our nearest representative, or write S. Morgan Smith Company, York, Pennsylvania.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

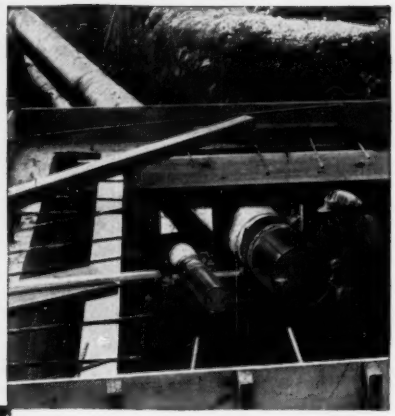
2

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

MR. ENGINEER:

LET'S FACE THE FACTS . . .

How can an underground piping system be watertight when you can't *AIR TEST* it?



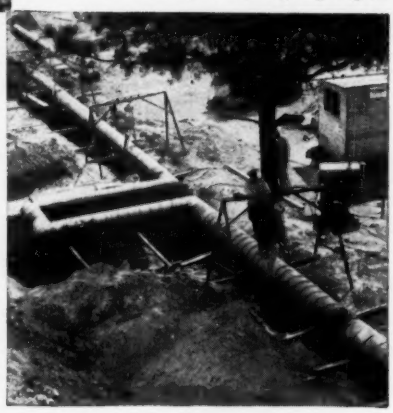
Test caps applied to unit ends for air testing full-welded conduit system.

WITH

RIC-WIL

During air test, conduit field welds are checked with soap solution.

Tested and ready for lowering long lengths.



YOU can AIR TEST your system...

The RIC-WIL method of making full-welded field closures allows the installer to AIR TEST the system prior to completion and backfilling. This simple 15 lb. pressure test gives greater assurance of a tight, leak-proof system. It provides the finest practicable protection to the owner against an initial system failure ...and most important, the long range effects of water corrosion.

Ask a RIC-WIL field representative for detailed information regarding Air Test procedure or write for catalog covering recommended field installation details . . . and remember, it pays to do it RIGHT the first time . . .

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency
SINCE 1910

RIC-WIL INCORPORATED — PREFABRICATED INSULATED PIPING SYSTEMS

BARBERTON, OHIO

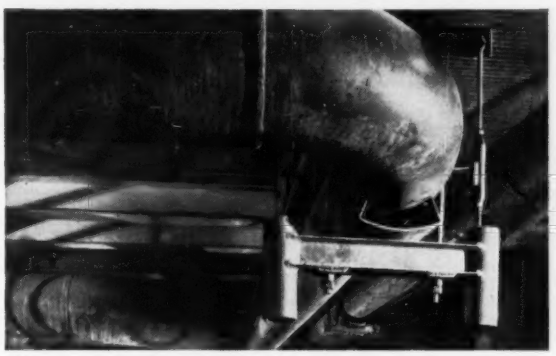
IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

BLAW-KNOX has what it takes—to provide these products and services

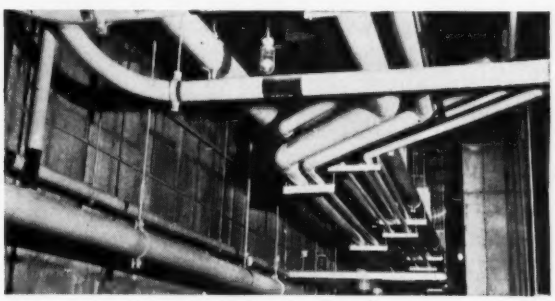
A Blaw-Knox automatic sprinkler system could have prevented this disastrous fire. Each year a serious fire strikes one out of seven manufacturing firms in this country. And out of every 100 firms who lose their records in a fire, 43 never reopen for business. So why take any chances.

Blaw-Knox engineers, fabricates and installs automatic sprinkler systems that are always alert to detect, confine and quench a fire at its origin. Qualified engineers custom-design systems that meet individual requirements—and fulfill all insurance standards and municipal codes. A Blaw-Knox automatic sprinkler system pays for itself in a few years through savings in reduced insurance premiums.

Let a Blaw-Knox fire-protection engineer study your needs, submit a layout and estimate, and tell you how you can pay for the system on our lease or deferred payment plan. For more complete information, write for Bulletin No. 2426—"Fire Can Destroy Your Business."



Blaw-Knox trapeze functional spring hangers, with the patented internal swivel action, support power piping in new generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. For further information, send for Catalog No. 54.



High temperature, high pressure oil tunnel piping in large steel mill is typical of many piping systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we will provide the service you need. For additional information, write for Bulletin No. 2443—"Piping for Industry."

BLAW-KNOX

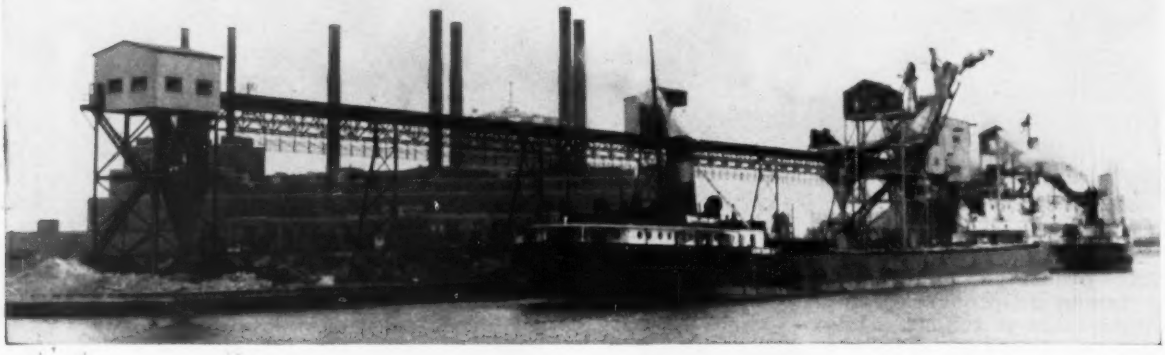
BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures . . . complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators . . . complete line of automatic sprinkler systems for standard and special hazards

Coal moves fast from railroad cars to ships at this transfer dock.



Rapid handling improves competitive position of 29 participating coal companies

These 20 Jeffrey vibrating feeders can take 4,000 tons of coal per hour from hoppers under car shake-outs. Electronic controls vary the feed to assure a uniform rate of flow to the 72-inch conveyor belt that carries the coal to boat loading telescopic chutes.

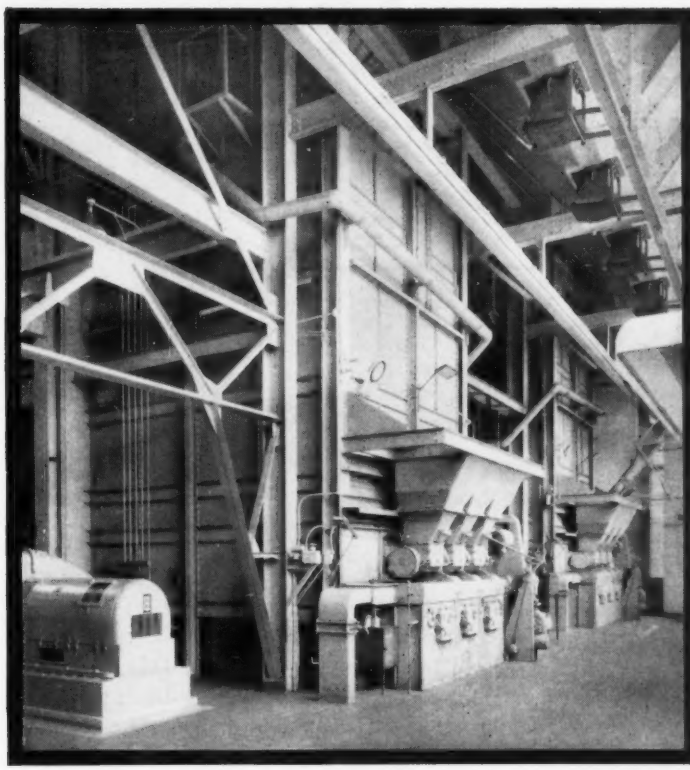
COAL is transferred quickly, economically, from railroad cars to ships here at Rail-to-Water Corporation's Chicago docks. This permits the 29 Midwestern coal companies who are partners in this enterprise to sell their coal on the Great Lakes.

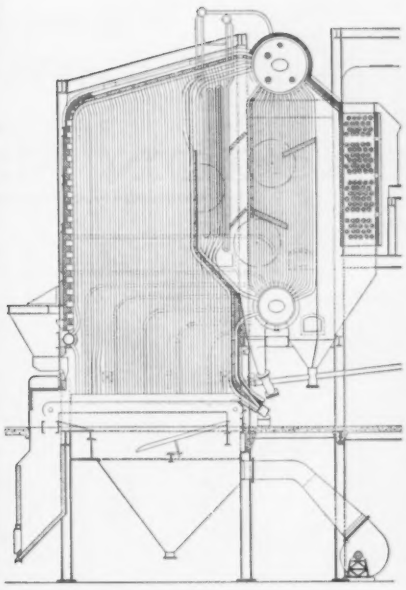
Typical equipment contributing to the speed which spells economy is this line of 20 Jeffrey electric vibrating feeders. They keep coal on the move with a minimum of attention, saving manpower. Vibrations are timed to their natural mechanical frequency, insuring minimum use of power and quiet, trouble-free operation. No wearing of parts, so maintenance costs and downtime are low.

Catalog 870 describes Jeffrey vibrating feeders. The Jeffrey Manufacturing Company, 932 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING





Longitudinal section of Union VO Type Steam Generator.

Union Boilers score new high at Notre Dame with 83% efficiency

Spread over a 1700-acre campus near South Bend, the University of Notre Dame is a self-sustaining community of 6,000 students and 500 faculty members.

To meet the demands of increasing enrollments, as well as to handle its own power requirements, the University expanded its steam heating plant and converted it to a steam-electric power plant. Three of the four original boilers were replaced with a pair of Union 2-drum VO Type Steam Generators. Spreader-stoker fired, each unit is equipped with a superheater and an economizer. Normal rating is 70,000 lbs./hr. at 470 psi and 750° F.

Although the heating load is increased 20%, and electric power is now supplied for all 75 buildings on the campus, boiler efficiency has been upped from 68% to more than 83%. *Coal consumption remains unchanged!*

This is just one job report where Union efficiency and dependability have achieved top-notch economy of operation. Across the nation, Union Boilers are giving similar service to industrial, institutional and public power plants, providing day-in and day-out, the best performance value in modern steam generating equipment.

GET FULL DETAILS

Information on the several types of steam generators built by Union is yours for the asking. Write for illustrated Catalog GB-153.

Aerial view of Notre Dame — with 75 buildings on a 1700-acre tract, this campus is a city in itself.

Steam-electric power plant makes campus community independent of outside power sources.

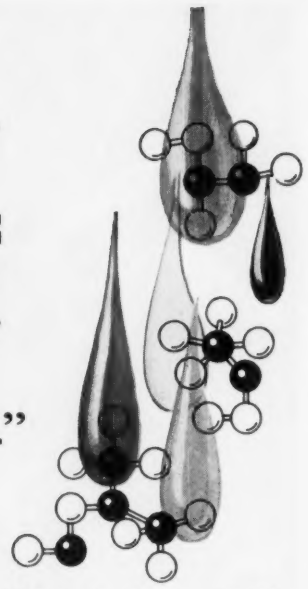
UNION

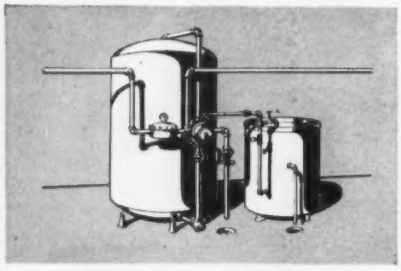
UNION IRON WORKS

ERIE, PENNSYLVANIA

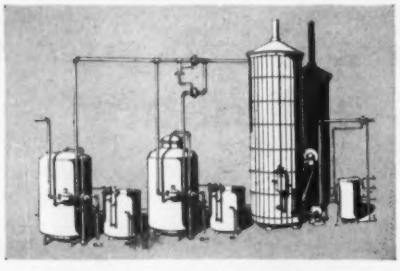
Quote and Unquote:—

"Elgin has dug deeper into ION EXCHANGE than any other firm"

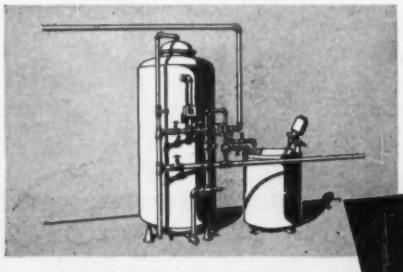




SOFTENING BY ION EXCHANGE — used to eliminate calcium and magnesium hardness from water. All types of ion exchangers available to meet specific conditions.



DEALKALIZATION BY ION EXCHANGE — produces soft water of controlled alkalinity. Various exchangers used, depending on requirements.



DEIONIZATION BY ION EXCHANGE — produces water of better than distilled quality. Ion exchangers of mixed-bed or multi-column design give "tailor-made" effluent to meet process or boiler plant requirements.

An engineer said this when he was asked why he had brought his not-too-simple water conditioning problem to the Elgin organization.

The particular way he put it set us to wondering how many men with water conditioning problems realize the great strides that have been made in ion exchange . . . how many recognize the vital importance of dealing with a firm that has played a leading role in ion exchange development and application.

It is always bad taste—often bad business—to boast; so we won't say that Elgin has dug deeper than *any* other organization. We simply say that certainly no firm has dug *deeper* into ion exchange application than has Elgin during nearly a half century of specialization.

It is squarely on the record that across the years we have *been a part* of the transition from the first simple greensand through the highly specialized ion exchangers and methods that are today accomplishing little short of water conditioning miracles. Just three of almost countless examples of this are given at the left.

Yes, today it can be said that there is a way to "make over" *any* water supply—*your* water supply—to exactly the kind and quality needed for *any* use. When you put your problem up to Elgin you are certain that Elgin "deep digging" will not only assure you the *right* way, but, still more important, the most *economical* way.

Never forget that Elgin works with *all* methods. No bias; no single-track thinking. One of our engineers will be glad to study your conditions and give you a demonstration of Elgin deep digging.

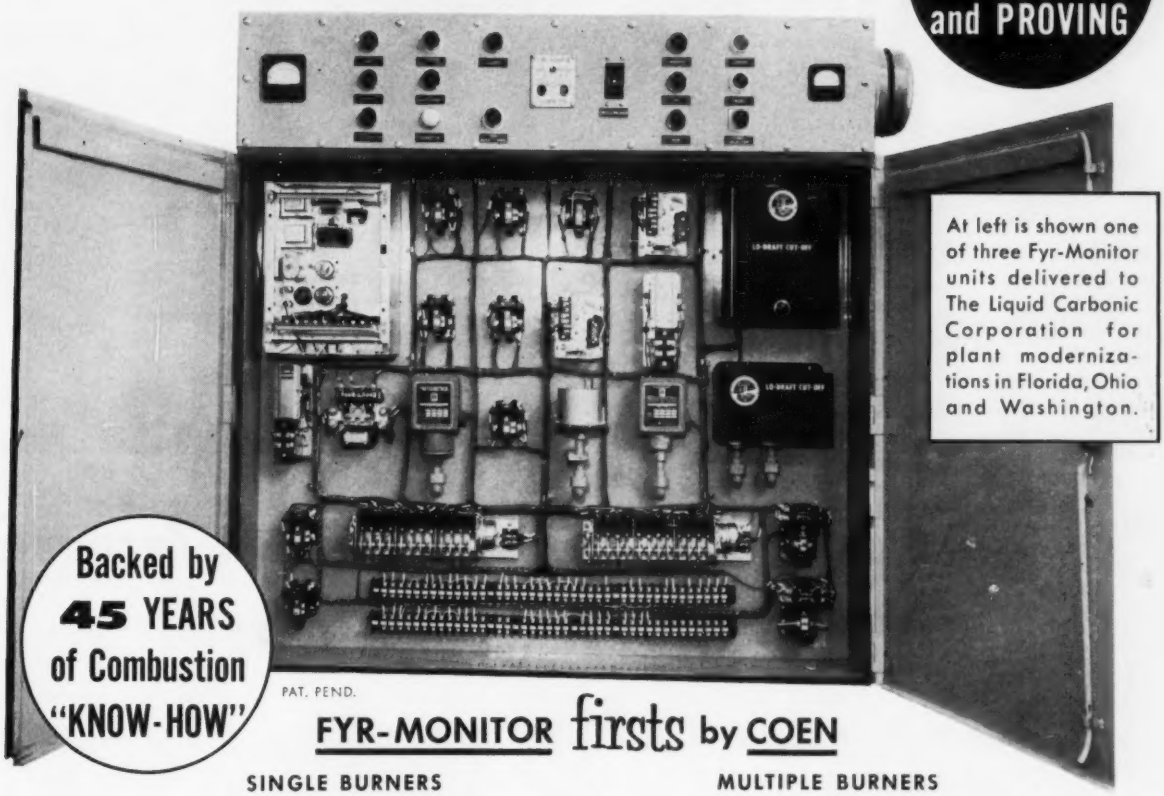
ELGIN
WATER CONDITIONING
SINCE 1908

ELGIN SOFTENER CORPORATION
130 N. Grove Avenue, Elgin, Illinois
Representatives in Principal Cities
In Canada: G. F. Sterne & Son Ltd., Brantford

SOFTENERS **ION EXCHANGERS** **FILTERS** **DEIONIZERS** **DEALKALIZERS** **CLARIFIERS** **DEGASITORS** **DEAERATING HEATERS**

AT LAST! ...a Completely Integrated Flame Safeguard & Boiler Control System FOR INDUSTRY

3 YEARS IN DEVELOPMENT and PROVING



At left is shown one of three Fyr-Monitor units delivered to The Liquid Carbonic Corporation for plant modernizations in Florida, Ohio and Washington.

Backed by 45 YEARS of Combustion "KNOW-HOW"

PAT. PEND.

FYR-MONITOR firsts by COEN

SINGLE BURNERS

- First to use flame safeguard unit for flame detection only for fully automatic use.
- First with immediate alarm on flame failure.
- First with key switch for optional re-cycle on low water limit.
- First to provide checked proving of pre-purge and light-off position.
- First to provide alarm after every limit failure as standard equipment—without relays.

MULTIPLE BURNERS

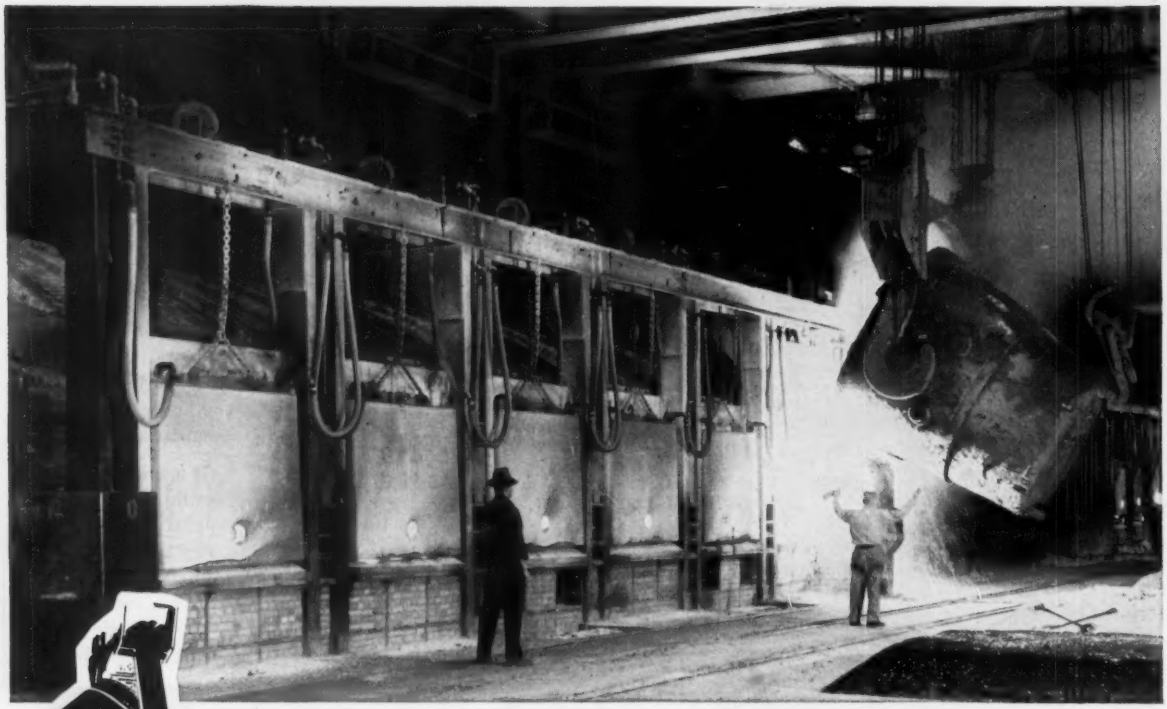
- First to provide mandatory timed sequence of boiler pre-purge, light-off and shut down for semi-automatic firing.
- First to provide individual cam timers for automatic ignition pilot proving and main flame monitoring of each burner.
- First to provide integrated packaged equipment to relieve operator of discretionary judgements in starting up. Sequential programming, as well as monitoring, automatically provided even for semi-automatically fired boilers.

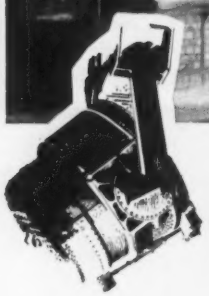
SINCE 1912 COEN

Fyr-Monitor TRADEMARK COMBUSTION CONTROL SYSTEM

Manufacturers of FYR-COMPAK (Packaged) BURNERS for Industry

COEN COMPANY | 40 Boardman Place • **SAN FRANCISCO** 3, California
Eastern Branch Office and Factory • **WEEHAWKEN,** New Jersey
Sales Representatives in Principal U. S. Cities; Canada, Mexico, France and Italy





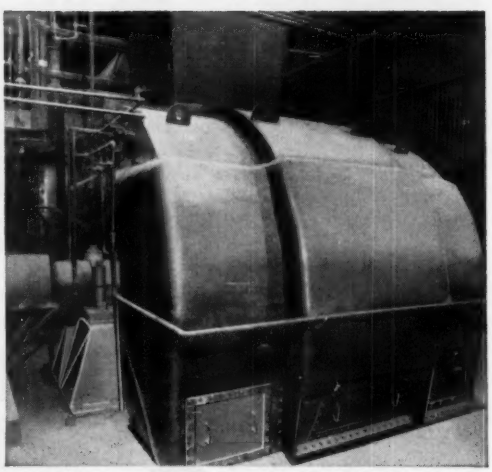
World's largest open hearth furnace utilizes Clarage Fans

600 TONS— enough steel in each heat for 300 automobiles. That's the capacity of Weirton Steel Company's new open hearth furnace at Weirton, W. Va. Weirton Steel is a division of National Steel Corporation.

Designed and built by Loftus Engineering Corporation, Gateway Center, Pittsburgh, this giant is completely automatic in operation.

As for so many other impressive installations, Clarage equipment was selected — a Clarage induced draft fan for the waste heat boiler and a Clarage forced draft fan for the furnace.

Investigate the advantages Clarage equipment offers for YOUR mechanical draft installations. Contact our nearest sales engineering office or write us for complete literature. CLARAGE FAN COMPANY, Kalamazoo, Michigan.



Clarage heavy-duty fan provides induced draft for waste heat boiler.

CLARAGE ... dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

result of an engineer's good common sense

This piping installation is here to stay, thanks to B&W Seamless Welding Fittings

THE engineer who specified B&W Seamless Welding Fittings on this boiler job knew what he was doing. He realized the system would have to be permanent and leakproof for many years to come. He also realized how much time and money could be saved in fabrication, and, of course, insulation. Therefore, it was only natural that he chose welded connections since they actually become part of the piping system and are as strong, or stronger than the pipe itself. Pipes nest closer and the overall system is considerably lighter.

B&W Seamless Welding Fittings are dimensionally accurate. Full radius, true circularity and smooth walls of uniform thickness provide a smooth, fast-moving flow even under highest temperatures and pressures.

This time, specify B&W Seamless Welding Fittings and Forged Steel Flanges for a permanent and leakproof piping system. They're available in a complete range of sizes and types in alloy (B&W CROLOYS) carbon and stainless steels.

FA-7907-FE3

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION — FITTINGS DEPARTMENT
3839 WEST BURNHAM STREET — MILWAUKEE 46, WISCONSIN

SEAMLESS WELDING FITTINGS AND FORGED STEEL FLANGES, SEAMLESS AND WELDED TUBULAR PRODUCTS — IN CARBON, ALLOY AND STAINLESS STEELS

where **POWER** is **VITAL**

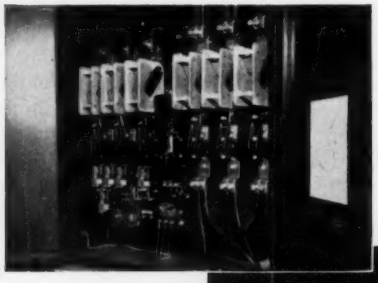
Hospitals rely on ASCO Automatic Transfer Switches

Here in the operating room, adequate lighting is as vital as the steady knife of the surgeon. *Throughout* the hospital, the functioning of life-sustaining equipment is dependent upon a continuous supply of adequate power. That is why automatic transfer switches by ASCO have been widely specified. When normal power fails they *automatically* transfer the load to an alternate source.

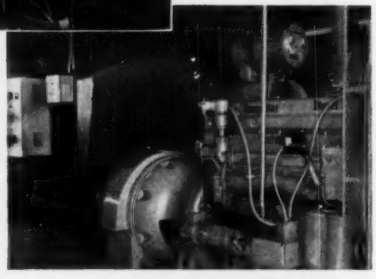
Dependable Control by ASCO

Where power and dependability are vital, ASCO switches give these signal design advantages: • **continuous duty rating** in either normal or emergency position • **capacity** to withstand inrush currents 20 times full load rating • **mechanical locking** providing high contact pressure • **single coil design** • **built-in time delay,** so that equipment ignores harmless momentary outages • **full-phase protection,** and other design features.

Write for Booklet 596 describing how to select an adequate automatic transfer switch. Or write in *on company letterhead* specifying Catalog 57-S1 covering complete line of ASCO transfer switches.



Typical installation: Valley Children's Hospital, Fresno, California. Comments Chief Hospital Engineer, Mr. C. G. Level: "It is a good feeling to know we have good dependable around-the-clock emergency power. I think we have the best unit to be had."



ASCO Bulletin 906 Automatic Transfer Switch at the Valley Children's Hospital; a Caterpillar D337 Diesel Electric Set is used as standby in case of commercial power failure.

Automatic Switch Co.
54-4 Hanover Road, Florham Park, N. J.
FRontier 7-4600

ASCO®

Unretouched photo showing typical return line corrosive action resulting from carbonic acid and dissolved oxygen in condensate.

BREAKING DOWN WITHIN

This section of pipe looks like new—on the outside. But take a look inside. Grooving action caused by carbonic acid and deep pitting, the result of dissolved oxygen attack, have almost completely penetrated the pipe wall.

Dearborn FILMEEN* prevents such destruction. FILMEEN forms a protective, non-wettable barrier between treated steam, or condensate, and metal pipe surfaces. By preventing the carbonic acid and dissolved oxygen from coming into contact with the metal, FILMEEN assures corrosion-free lines. FILMEEN is only one of many Dearborn water conditioning products scientifically developed to control specific corrosion problems. Others eliminate scale, sludge, carry-over and similar difficulties.

Power engineers in leading industrial and commercial plants place their confidence in Dearborn's 70 years of experience in water chemistry. They have found the answer to the demand for complete plant protection in Dearborn Supervisory Service—a properly balanced water conditioning program which combines quality products with correct, technically supervised control methods and test procedures.

Let a Dearborn Engineer survey your plant and recommend the type of water control program best suited to your requirements.

**FILMEEN is the trade-mark of a corrosion-inhibiting compound patented and produced exclusively by Dearborn Chemical Company. U.S. Pat. No. RE 23614.*

Dearborn®

...a leader in water conditioning and corrosion control for 70 years

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PO, Chicago 54, Ill.

Gentlemen: ☐ Have a Dearborn Water Conditioning Engineer call.
☐ Send me complete information on Dearborn Water Conditioning Program.

Name.....*Title*.....
Company.....
Address.....
City.....*Zone*.....*State*.....

ROTARY CAR DUMPER

Rigid and Simple Construction

(No movable platen)

Balanced Design • Economical Operation

RAILROAD CAR SHAKERS

■ *Write for Bulletin 200*

EASTERN CONSTRUCTORS, INC.

Poland, Ohio

"ZIP-ON"

PROTEKTINSUL

Miracle "Zip-On" Protektinsul Pipe Insulation Jacket installed in boiler room of Esso Bayway Community Center, Elizabeth, N. J.

Easy "Zip-On" installation ■ No maintenance painting ■ Excellent appearance ■ Non-inflammable ■ Chemical and mildew proof ■ Perfect vapor barrier.

FREE: Colorful, illustrated PROTEKTINSUL brochure, no obligation.

MIRACLE ADHESIVES CORPORATION

250 Pettit Avenue — Bellmore, L. I., N. Y.

When it's B/M "Matched Metering"

—you know it's accurate!

The high fidelity of Burgess-Manning Electric and Electronic Meters is made possible only by the Burgess-Manning null-balance inductance bridge, servo-powered meter principle employed. To this has been added the refinement of a calibrated cam, which matches the calibration of the recorder-totalizer and the differential producer for perfection thru "Matched Metering." Burgess - Manning electric transmission is suitable for distances up to 5000 feet. You'll never regret having specified Burgess-Manning "Matched Metering" for greatest overall accuracy.

Request Catalog 800

Burgess-Manning Meters are also available in mechanical types.

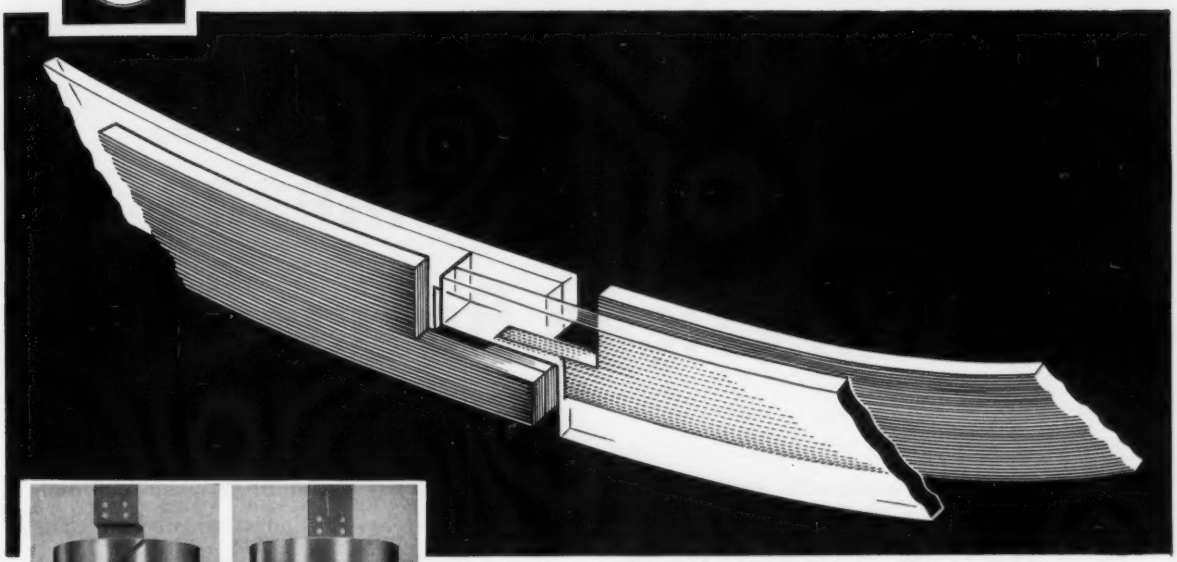
BURGESS-MANNING COMPANY

PENN INSTRUMENTS DIVISION

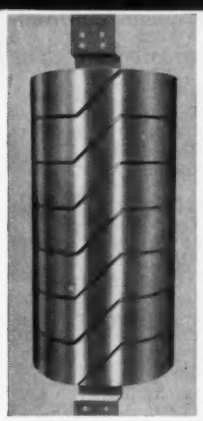
4114 Haverford Ave., Philadelphia 4, Pennsylvania

Instrumentation and Controls for water, steam, gases, sewage and industrial wastes

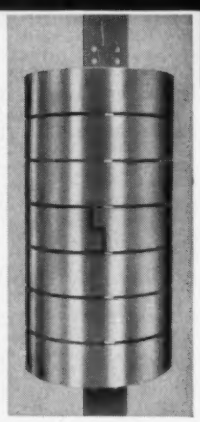
UNIT SUBSTATION TRANSFORMERS



Crossover point. Showing how inner winding connects with outer winding at center of transformer secondary.

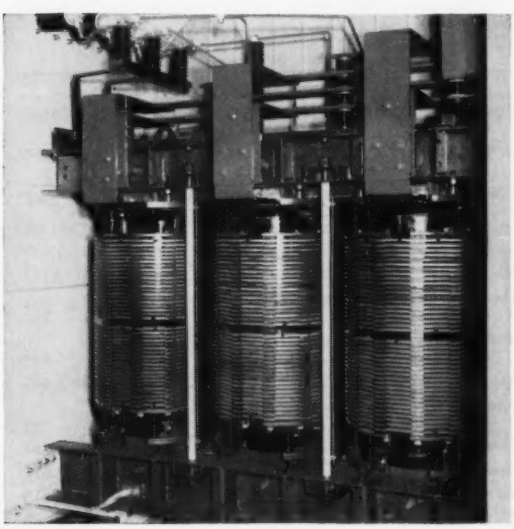


Diagonal connections between rings.



Crossover point on reverse side of transformer.

BRUTE STRENGTH SECONDARIES WOUND FROM SOLID BUS— NO MECHANICAL JOINTS



Completed dry-type transformer mounted in ventilated housing.

From one end of the secondary to the other in these I-T-E unit substation transformers, electricity flows through solid copper bus bar.

This is a unique design for high current secondary windings embodying great structural strength, plus low reactance and high conductivity. Lengths of copper bus, cut on a diagonal and formed into rings, are brazed together below the diagonal gap in such a manner as to form a continuous electrical winding.

Where greater current carrying capacity is required, two such windings are paralleled, but a crossover at the midpoint causes each of the parallel paths to have half its turns in the outer layer and half in the inner—equalizing the impedance of the two parallel paths and distributing the reactance evenly.

Write for complete information. I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Streets, Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

Transformer & Rectifier Division

What Research Means to American Business

American industry plans to invest $150 billion in new plant and equipment during the next four years—more than in the five years 1952-1956. It plans to carry out this record investment even though manufacturing capacity has nearly doubled since World War II. These facts are reported in McGraw-Hill's tenth annual survey of Business' Plans for New Plants and Equipment. They contradict many long-established theories about investment in capital goods.

According to the textbooks, a high and rising level of capital investment is generally followed by a decline. The bigger the rise—so the old theory goes—the bigger the decline will be. But, after a decade of high-level investment and an especially strong rise in the past two years, industry now has plans to keep right on with near-record outlays for plant and equipment. Does this mean some new factor has been added, to change the investment cycle?

The New Factor—Research

The latest McGraw-Hill survey points out one new factor which, more than any other, is changing the nature of the investment process. This is the record outlay planned by U.S. corporations for **scientific research and development**—to create new products and develop new industrial processes. The rapid growth of research in industry, and plans for even more remarkable growth in the years ahead, are shown by the accompanying table.

This year industry plans to spend $7 billion on research and development—up 20% from 1956. By 1960 it will spend $9 billion—enough to create a major new industry.

By 1960 manufacturing industry expects sales to be up 26%—with half the increase in products that were not made in 1956.

Growth of Research and Development Expenditures

(Millions of Dollars)

			PLANNED	
	1955	1956	1957	1960
Machinery	408	506	577	704
Electrical Equipment	950	1,149	1,310	1,637
Aircraft and Parts	1,038	1,558	2,274	3,161
Fabricated Metal Products and Ordnance	134	165	174	210
Professional and Scientific Instruments	185	252	300	453
Chemicals	440	498	528	617
Paper, Rubber, Stone, Clay and Glass Products	149	174	196	233
Petroleum Products	171	205	225	277
Other Manufacturing	1,038	1,279	1,388	1,557
Non-manufacturing industries	254	310	347	419
ALL INDUSTRIES	4,767	6,096	7,319	9,269

What Research Is Doing

Here are some examples of how industrial research is opening up new markets, or compelling the modernization of old facilities:

New automatic controls in petroleum refining will raise the quality of gasoline and reduce the time required for production. A new process for recovering oil from depleted wells promises to multiply our potential reserves.

A new process for treating iron ore will permit the ore to be fed directly into steel furnaces—without the need for blast furnaces or coke ovens.

New turbine engines—made possible by the development of heat-resistant alloys for turbine parts—offer greatly increased power for aircraft, ships and automobiles.

Altogether, industry plans to introduce more new products in 1957-1960 than in any previous four-year period. It also plans new processes on a scale that will make much of our present capacity obsolete. These new products and new processes are the secret behind continuing plans for high investment.

One-third of all manufacturing firms are building new plants this year to produce new products, and by 1960 this may account for 10% to 20% of all capital expenditures. At the same time, manufacturing companies report that over half their capital expenditures in the next four years will be for modernization of equipment and introduction of new processes. Thus the preponderant share of new investment will be based on developments growing out of research.

A New Kind of Prosperity

The keen interest of U.S. business firms in scientific research points the way to a new kind of prosperity for our economy—a prosperity based on deliberate creativeness. As long as we can create new products that will offer better value to consumers or cut costs to manufacturing firms, business will continue at a high level—not at fever pitch, perhaps, and it is to be hoped not at an inflationary pitch. But based on a steady stream of new products and processes, we can have a high level of general prosperity that defies the old laws of boom and bust.

It's Not Automatic

Of course, there is no guarantee. New products do not spring up by magic as the medieval alchemists hoped they would. They are found as the result of long and expensive effort in laboratories and pilot plants. This effort requires an increasing number of trained scientists and engineers. In 1957 alone, manufacturing companies report they will need 7% more of these highly trained people in research and development. And by 1960, they will need an additional 15% to carry out planned research programs.

The effort to maintain prosperity — as well as the national defense effort — will depend increasingly on this supply of scientific and technical personnel. But if we can supply the people, industry now has the plans for a research effort that will put an end to the spectre of idle plants and idle workers.

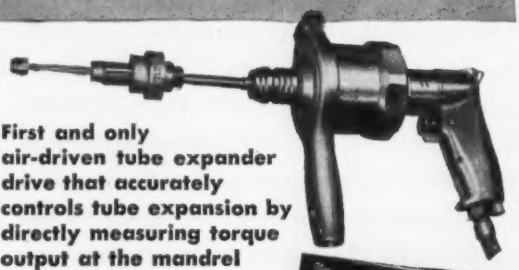
This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

For Expanding
Heat Exchanger Tubes

NEW WILSON Torq-Air-Matic



First and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel

Only the Wilson Torq-Air-Matic offers all these features: air driven, automatic trip-off, completely integrated, non-electrical, non-frictional, calibrated in ft lbs torque, lightweight, simply adjusted.

Send for your copy of Wilson Bulletin 55.

Wilson Heavy-Duty Air Driven Cleaners

offer quick way to clean fouled heat exchanger tubes

Wilson Tube Cutter

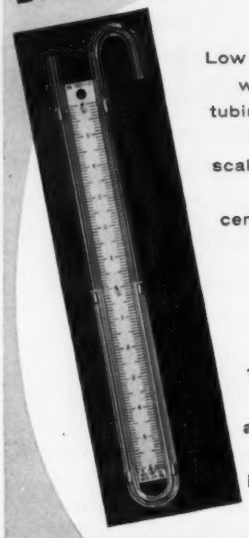
easy to use, does fast job, a fine, reasonably priced tool

Representatives in principal cities
Thomas C. Wilson, Inc. • 21-11 44th Ave., Long Island City 1, N. Y.
Cable address: "Tubeclean", New York

WILSON TW-868

TUBE CLEANERS • TUBE EXPANDERS

Dwyer FLEX-TUBE MANOMETERS SERIES 1225



Low cost manometers of heavy walled unbreakable Butyrate tubing. Graduations and figures are silk-screened on fibre scale and protected by lacquer coating. Scale is on center line of tube, eliminating parallax errors, and is adjustable vertically for accurate zero adjustment.

Two groups: 1225 (conventional U-tube) and 1225U (U-tube with an inverted U at top for hose connection). Both groups in 12", 24" and 36" lengths. Write for Bulletin D-11.

F. W. DWYER MFG. CO.
P. O. BOX 373 -J MICHIGAN CITY, INDIANA

Coming in September

* * *

Power's 75th ANNIVERSARY ISSUE

WATCH FOR IT!

WHERE TO BUY

Featuring additional products specialties and services for power plants

This WHERE TO BUY section is a special classification for manufacturers desiring advertising in space units smaller than the minimum run of book display space. Space is available in this section in units from one to four inches. Each advertisement is indexed. For low rates write: Classified Advertising Division.
POWER, 330 West 42nd St., New York 36, N. Y.

STEEL PIPE & TUBING

• CHROME MOLY • CARBON MOLY
• CARBON STEEL • STAINLESS

Widest Range of Sizes & Specs in the U. S.
WRITE FOR STOCK LIST

MIDCONTINENT TUBE SERVICE, INC.
2308 Oakton St., Evanston, Ill. DA 8-4030

PAINTING CONTRACTORS

Specialists in
Power Plants, Refineries, Chemical Plants

HARTMAN-WALSH
5078 Easton St. Louis 13, Mo.

PROFESSIONAL SERVICES

CONSULTING DESIGN EXAMINATIONS PATENTS
CONSTRUCTION PLANS SURVEY • REPORTS TRADE MARKS

BLACK & VEATCH

Consulting Engineers

Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction,
Investigations, Valuation and Rates

1500 Meadow Lane Pkwy, Kansas City 14, Missouri

THE LUMMUS COMPANY

Engineers and Constructors

385 Madison Ave., New York, N. Y.
Chicago . . Houston . . London
Paris . . The Hague . . Montreal
Caracas . . Bombay

J. E. SIRRINE COMPANY

Engineers

Power Plant Design Water — Steam Utilization — Consultations Reports Plants

Greenville South Carolina

BURNS & McDONNELL

Engineers—Architects—Consultants

Kansas City, Mo. Phone
P. O. Box 7088 DElmar 3-4375

LUTZ AND MAY COMPANY

Consulting Engineers

Steam, Gas & Diesel Power Station
Pumping Plants—Electric Systems
Reports—Design—Appraisals

1009 Baltimore Kansas City 6, Mo.

STANLEY ENGINEERING COMPANY

Consulting Engineers

Hershey Building 208 S. LaSalle St.
Muscatine, Ia. Chicago 4, Ill.

GILBERT ASSOCIATES, INC.

Engineers and Consultants

Design and Construction Supervision
Mechanical • Electrical • Structural
Sanitary • Chemical Laboratory
Business and Economic Research

New York **Reading, Pa.** Washington

PIONEER SERVICE & ENGINEERING CO.

Consulting and Design Engineers
Purchasing
Specialists in
Financing, Accounting Other Operations
231 So. La Salle St. Chicago 4

SWANSON, WRIGHT & CO. ENGINEERS LTD.

Consulting Engineers

Forest Product Industries
Thermal Power Plants
Industrial and Process

2210 West 12th Ave., Vancouver 9, B.C. CEdar 1154

INTERNATIONAL ENGINEERING COMPANY, INC.

Engineers

Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign

74 New Montgomery St., San Francisco 5, Calif.

SANDERSON & PORTER ENGINEERS

Construction

Reports *Surveys*

New York New York

TIPPETT & GEE CONSULTING ENGINEERS

Mechanical—Electrical—Thermodynamic—Structural
Design—Studies—Supervision
Power Stations—Transmission—Distribution
Industrial Plants—Process

1333 North Second Street Abilene, Texas

THE KULJIAN CORPORATION

Engineers - Constructors - Consultants

POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
Utility • Industrial • Chemical

1200 N. Broad St. Philadelphia 21, Pa.

SARGENT & LUNDY

Engineers

140 South Dearborn St. Chicago, Illinois

WATER SERVICE LABORATORIES, INC.

Specialists in Water Treatment for Corrosion Prevention

Main Office:
423 W. 126 St. New York 27, N. Y.

PETER F. LOFTUS CORPORATION

Design and Consulting Engineers

Electrical • Mechanical • Structural
Civil • Thermodynamic • Architectural

First National Bank Building
Pittsburgh 22, Pennsylvania

SEELYE STEVENSON VALUE & KNECHT

Consulting Engineers

Mechanical—Electrical—Civil
Surveys Reports Design

101 Park Avenue New York 17, N. Y.

THE J. G. WHITE ENGINEERING CORPORATION

Design-Construction-Reports-Appraisals

80 Broad Street, New York 4

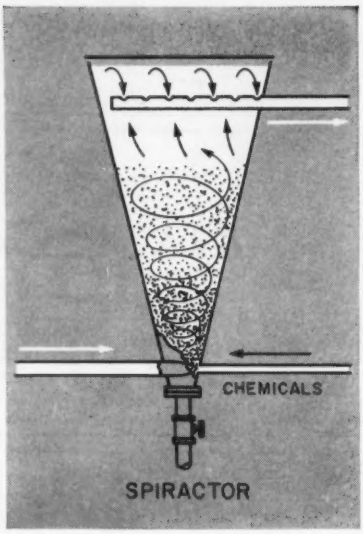
HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 3 OF A SERIES)

Precipitation Equipment

Basically, precipitation equipment converts water impurities to the form of large, dense, suspended particles; then it separates these particles from the water.

The first step is accomplished with chemicals. Hardness, for example, is precipitated by adding lime (and soda ash, if required). The precipitated hardness and other suspended impurities such as turbidity or oxidized iron and manganese are made to coalesce into larger particles by adding alum or iron salts. These salts also form their own dense, floc-like precipitate which absorbs the suspended material to form even larger particles.

The insoluble particles must then be separated from the water. Early methods used settling basins where precipitates settled slowly as the water flowed through, requiring 2 to 4 hours or longer detention time. Modern equipment keeps precipitates in suspension to serve as nuclei on which fresh precipitates form. This results in larger, denser particles that absorb more of the fine particles and are more easily separated from the water.



SPIRACTOR® for softening clear hard water.

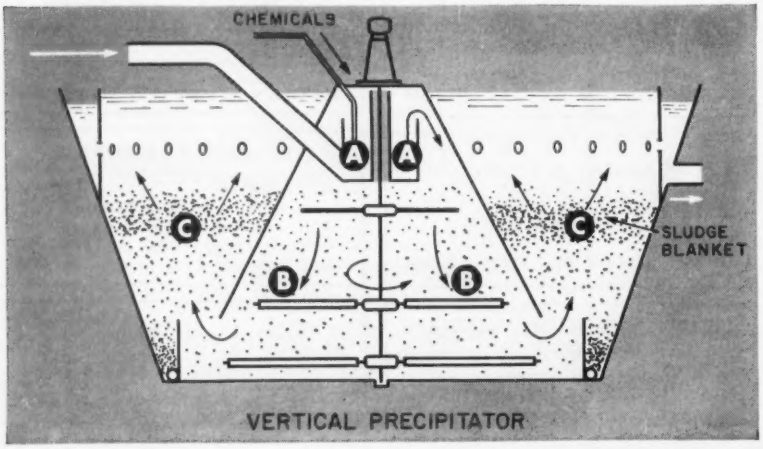
The water, lime (and soda ash if required) enter at bottom of cone. The treated water rises with a swirling motion and suspends a bed of fine granules of calcium carbonate or other catalyst which speed softening reactions. The precipitated hardness deposits on the granules which become heavy and work down to the bottom of the cone where they are drawn off then easily dried and dumped. The softened water rises above the bed of granules to the outlet.

Provides very high flow rates in relation to its small floor space. Detention period: 8 to 10 mins. Recommended for municipal or cooling water.

PRECIPITATOR for removing hardness, turbidity, color, iron, manganese.

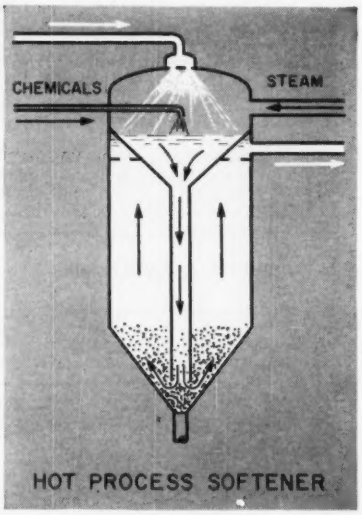
Chemicals are mixed with influent at A. As water flows downward through zone B, precipitates form, "seeded" by recirculated sludge. At C, floc has formed a sludge-blanket filter suspended by upward motion of the water. Excess sludge is concentrated and periodically drawn off.

Because of short detention time, capacity is about 4 times that of conventional coagulation and settling basins of the same size. Basic designs include vertical types as illustrated, vertical types for installation in existing tanks, horizontal types built into new or existing concrete basins and smaller "package" types for bottling plants, etc.



HOT PROCESS SOFTENER for removing hardness and silica from boiler feedwater.

The water is first heated to within a few degrees of boiling by spraying through steam. Then it is mixed with softening chemicals which react very rapidly and efficiently at this temperature. It then flows down to the bottom and upward through a suspended sludge blanket of precipitated solids which effectively reduces silica and filters out the bulk of the turbidity. Combination softeners with built-in condensate heater and storage compartment and/or steam scrubber (deaerator) are also available.



The effluent is filtered to remove last traces of suspended matter. Where zero hardness is required, Hot Process Softeners may be followed by a zeolite softener.

• • • •

For detailed information on these or any other types of water conditioning equipment, write: The Permutit Company, Dept. P-7, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®

rhymes with "compute it"

Water Conditioning

Ion Exchange • Industrial Waste Treatment

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $25.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An Advertising Inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.65 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to POWER, 330 W. 42nd St., N. Y. 36, N. Y. for August issue closing July 3rd.

REPLIES (Box No.): Address to office nearest you c/o this publication Classified Adv. Div.
NEW YORK: P. O Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

Hospital Engineer. Glens Falls Hospital, Glens Falls, New York. 50 miles north of Albany on Hudson River foothills of Adirondack Mountains. 300 bed hospital. Require technical education and several years experience chief engineer of hospital. Fine American community and good labor market. Excellent area to raise family and wonderful outdoor recreation summer and winter. Salary open; will depend upon experience. William G. Illinger, Superintendent.

Designers — Electrical — Piping — Struct. . . . Power Plants and Industrial Buildings, Marbarry Corp., 120 Greenwich St., New York City 6, N. Y. REctor 2-3749.

Foremen, for modern steam and electric generating plant located in midwest. Required preparation: High School graduate or equivalent and minimum of five (5) years experience helpful but not necessary. Please send resume and salary requirements to: P-4991, Power.

SELLING OPPORTUNITIES OFFERED

Water conditioning equipment manufacturer desires agents for New England and North and South Carolina area. RW-3789, Power.

Established manufacturer with complete line of water treatment, fuel oil treatment and soot remover products desires representation in New England and Midwest areas. Excellent opportunity for men with allied lines and following in industrial power plants. High Commissions. RW-4655, Power.

POSITIONS WANTED

Power Plant Superintendent, age 35, married, technical education, 12 years experience in all phases of operation and maintenance of turbo-electric power plants. PW-4733, Power.

Electrical Engineer, BSEE 1951. Age: 27. Single, 4 years diversified experience in nuclear field including reactor construction. 21 month military service as fire control instructor. Desire position permitting foreign employment and/or world travel, preferably in nuclear field. Salary open. PW-5211, Power.

M.E. with 9 years experience in heat utilization work in pulp and paper mills including two years operating experience, desires position in modern high pressure steam-electric station. Age 30, Canadian. PW-5028, Power.

Plant Engineer—Desires position for progressive plant betterment on long range program. Integrated experience Power and Related Plant Utilities, Budgeting, Administration. PW-5134, Power.

ENGINEERS

If you have been looking for an Employment Agency that is skilled in the **STATE OF THE ART** of Technical Recruitment and **RELIABILITY OF INFORMATION** concerning positions, why not communicate with us at once! **ALL POSITIONS FEE PAID.**

FIDELITY PERSONNEL SERVICE
1218 Chestnut St. Phila. 7, Pa.
Specialists in Aviation, Electronics and Nucleonics

ELECTRICAL ENGINEERS

Several attractive openings in New York offering a unique opportunity to join a highly respected company with excellent prospects for professional growth and personal achievement.

LIGHTING ENGINEER

Graduate E.E. with substantial background in layout, design, selection and application of lighting for utility power plants, industrial and office buildings. Capable of assuming complete responsibility for all technical problems related to lighting engineering.

GRADUATE E.E.'s

2-5 years experience in the engineering and design of steam electric stations and substations. Preparation of equipment and material specifications, supervision of preparation of design drawings, including control wiring diagrams.

Please send complete confidential resume to:

P-5412, POWER
Class. Adv. Div.
P.O. Box 12, N. Y. 36, N. Y.

SERVICE ENGINEER INSTRUMENTS AND CONTROL

Manufacturer of electro-mechanical power and process instruments and control equipment has opening for a Service Engineer. Located in lakeside city of 32,000 with excellent schools, recreational facilities and residential areas.

Familiarity with steam power plant operation and instrumentation preferred. Work involves field calibration and adjustment of Hays equipment preparatory to placing it into operation and instructing users.

Position requires man with high degree of initiative capable of working and completing jobs without direct supervision. Salary, insurance and vacation plans excellent.

Send resume to S. M. Rudolph, V. Pres.

THE HAYS CORPORATION
MICHIGAN CITY, INDIANA

MECHANICAL PROJECT ENGINEERS

Ebasco, a long established name in power plant engineering design and construction, has need for Mechanical Project Engineers.

IF YOU —have an engineering degree plus 7-10 years experience in the engineering design or construction of public utility power plants . . . Can handle people and have the ability and well-rounded background to assume full responsibility for a project from inception till ready for operation . . .

THEN WE —can offer you an attractive salary, and a New York location with all its vocational, educational and cultural advantages . . . And can offer you an excellent chance for advancement in the engineering and construction field.

• • • • • • • • • • • • • • • • • •

There are also several positions offering a similar potential for graduate engineers with 3-5 years experience in engineering design and construction of public utility power plants as JOB ENGINEERS.

• • • • • • • • • • • • • • • • • •

Write fully and
in complete confidence to
Mr. W. W. Patterson
Employment Manager

EBASCO
SERVICES INCORPORATED
Ebasco Building
2 Rector St., New York 6, N. Y.

STEAM ENGINEER

Large paper manufacturer in northern New England has an immediate opening in its Steam Power Plant for a Mechanical Engineer with steam background. Position offers excellent early opportunity for advancement leading to superintendent. Send resume giving complete information on educational background and work experience. All applications will be treated as confidential.

P-5000, POWER
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y

ELECTRICAL (power) ENGINEERS

IBM OFFERS CHALLENGING CAREERS IN PLANT ENGINEERING

Design electrical construction for industrial laboratories and commercial buildings; maintenance and expansion of existing facilities. Must have E.E. degree or equivalent experience. Location—Poughkeepsie, N.Y. Write, outlining experience and qualifications to:

Mr. R. A. Whitehorne, Dept. 13407,
Manager of Engineering Recruitment,
IBM, 590 Madison Ave., New York 22, N. Y.

INTERNATIONAL BUSINESS MACHINES CORP.

EMPLOYMENT OPPORTUNITIES
(CONTINUED FROM PRECEDING PAGE)

CORROSION ENGINEERS

Openings for young Electrical Engineers interested in training for corrosion engineering positions involving corrosion testing and solution of corrosion problems. Some field construction experience desirable on heavy construction such as steam or hydro-electric plants.

These are staff positions with a long-established engineering and construction company. Excellent opportunities for advancement in a new and expanding engineering field.

Please send complete confidential resume to:

P-5408, POWER
Class. Adv. Div.
P.O. Box 12, N.Y. 36, N.Y.

PROJECT ENGINEERS

Permanent staff positions open for graduate mechanical engineers with 3 years minimum experience as Project Engineer in design of steam electric power plants. Salary will be commensurate with experience and ability. Excellent working conditions. Liberal company benefits.

Please give full details—including personal data, education, experience and salary desired in your reply.

Write or call collect, to:

THE KULJIAN CORPORATION
Engineers • Constructors
1200 N. Broad St., Phila. 21, Pa.
STevenson 2-9000

MECHANICAL ENGINEER

Maximum Age 35

Steadily expanding Electric Utility in SOUTHERN CALIFORNIA needs a MECHANICAL ENGINEER to perform TECHNICAL ASSISTANT'S duities in its STEAM DIVISION. Graduate preferred but will consider practical experience in Steam Plant Operations. Excellent future with progressive Company with advanced personnel policies and all employee benefits. Please write or apply at Personnel Office of

CALIFORNIA ELECTRIC POWER CO.
3771 Eighth St., Riverside, Calif.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

UNDISPLAYED ——***RATES***—— ***DISPLAYED***

(Not Available for Equipment Advertising)

$1.65 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers count as one line.

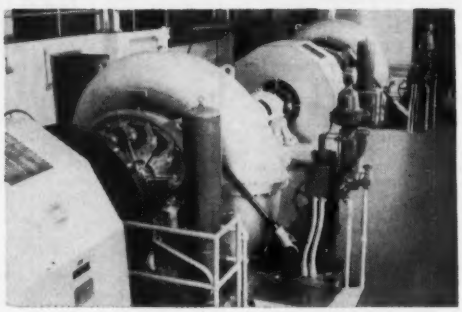
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns, 30 inches to a page.

Send new ads or inquiries to Class Adv Div. of POWER, P.O. Box 12, NY 36, NY August closes July 3.

TWO 1,500 KW HYDRO ELECTRIC PLANTS

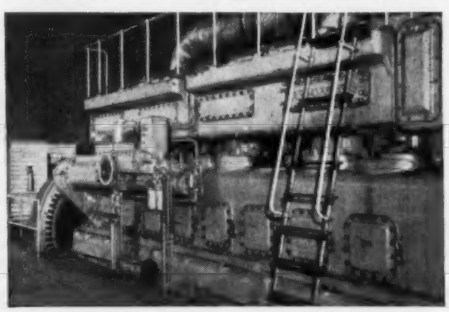


2000 HP Pelton type Turbines, 160 ft. head, 600 RPM, 4160 Volt, 3 Phase, 60 Cycles, .8 PF, Direct connected excitors, complete modern cubicle. Three 1250 KVA Transformers 66,000-38,150-4160 Volt, and taps. Plants were in service less than four years and are in new condition. Immediate delivery.

GENERAL MACHINERY LIMITED
GRANVILLE ISLAND — VANCOUVER, B. C.

MODERN SLOW SPEED
DIESEL ELECTRIC GENERATING SET
OFFERED AT CONSIDERABLE SAVING

ALSO AVAILABLE
•
WORTHINGTON
BB5
100 KW
600 RPM
3/60/480
•
Other Sets from 20 KW to 1200 KW



COMPLETE WITH ALL AUXILIARIES
—
Other Sets from 20 KW to 1200 KW

FAIRBANKS MORSE MODEL 33F16
1125 KW 300 RPM 3/60/480V

NATIONAL METAL & STEEL CORP.
1251 NEW DOCK STREET, TERMINAL ISLAND (LOS ANGELES HARBOR), CALIF.
CALL LOS ANGELES: NEvada 6-9871

DIESEL DIVISION

BELYEA-RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS
RE-NU-BILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—1375 H.P. G.E., MCF, 415 V, 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V. DC, 2300/4000 V, 720 RPM 3 ph 60 cycle.

1—1200 HP G.E. MPC, 600 V, D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 HP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

1—850 HP, G.E., Type MCF, 260 volt DC, 800/1200 RPM, and 675 KW, M-G Set, DC Gen., G.E., Type MCF, 260 volt, DC, with 1100 HP, .7 PF, G.E. Synch. Motor Type ATI 2300/4600 volt, 900 RPM, 3 phase 60 cycle.
Above with variable voltage control.

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. BB	SF806S	4800/2400	1800
1	800	G.E.	MT	2300	293
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D P.	2300	500
1	500	Whse.	CW	550	350
1	400	Whse.	CW	440	514
1	350	Cr. Wh.	SIZE-718R	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	250	Cr. Wh.	MT-424Y	4000	257
1	250	G.E.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
3	200	G.E	IM	2200	435
1	200	G.E.	MT-557Y	2200	1760
1	150	Whse.	CW30E17	2300	435

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	650	G.E	FT-559BY	440	3570
4	500	Whse.	CS 1216	2200	500
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	1K	2200	500
1	300	G.E.	KT-550A	2300	1775
1	200	G.E.	1K-17	440	580
2	200	G.E	KT-557	440	1800
1	150	Whse.	CS	440	580

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4600
2	2100	G.E.	514	250/300	2300/4600
1	2000	G.E.	514	660	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1000	G.E.	900	260	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	1000	G.E.	514	600	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
3	300	G.E.	1200	250	2300
2	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/2300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
1	3000	G.E	OISC	3	33000x2300
1	1500	G.E.	PYRANOL	3	auto 4000/4200/4400
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x85/55
1	833	G.E.	OISC	1	13800x460
3	500	KUHL	OISC	1	13800x6900
3	200	Al Ch.	OISC	1	2300x230/460

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	6600/11000/6600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/800

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	10000	Whse.	Condensing 650 lbs. 750° F.T.T. Surface Condenser Dir. Conn. Exciter.
1	5000	G.E.	Auto Extraction Condensing 650 lbs. 750° F.T.T. Auto.
1	1000	Moore	Auto. Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.

BELYEA COMPANY INC.

43 Howell St., Jersey City 6, N. J.

GUARANTEED REBUILT POWER EQUIPMENT

HERE'S A WIDE SELECTION FROM OUR GIANT STOCK

SLIP RING MOTORS

3 Phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

HP	Make	Type	Speed
2500	*G.E.	MT	257
1200	*Al-Ch.	ANT	1800
600	*G.E.	MT	450
500	G.E.	M-6345	1200
300	G.E.	IM-17B	600
250	*G.E.	IM	720
200	G.E.	IM	600
200	*Westg. (2)	CW	514
200	*Westg.	CW-905-A	514
150	Cr.-Wh.	50-R	1800
150	Westg.	CW	450
125	G.E. (2)	IM-15A	600
100	G.E.	IM-13A	1800
100	G.E.	MTC-5548	900
100	G.E.	IM	720
100	G.E.	IM	600
100	G.E.	IM-15A	450
75	G.E.	MT-347	1200
75	G.E.	IM	1200
75	Al-Ch.	ARY-223C	1200
75	G.E.	MT-356	900
75	Al-Ch.	ANY-26F	900
75	Al-Ch.	ARY	720
75	G.E.	MT-352	720
75	G.E.	MT-556	720
75	G.E.	IM	600
60	Al-Ch.	ARY	1200
60	G.E.	MT-546	1200
60	*G.E.	MT-536	1200
60	*Westg.	CW-762C	900
50	Westg.	CW	1800
50	G.E.	IM-11A	1800
50	*Al-Ch.	ARY	1200
50	Westg.	CW-636A	1200
50	*G.E.	MT-536	1200
50	Westg.	CW-658-A	900
50	G.E.	MT-336	900
50	G.E.	MT-346	720
50	Al-Ch.	ANY-26F	600
50	G.E.	IM	450
40	G.E.	MT-532	1200
40	*G.E.	MT-336	900

SLIP RING MOTORS

Crane & Hoist Service
3 Phase, 60 Cycle, 220 or 440 Volt

HP	Make	Type	Speed
80	G.E.	MTC-5552	600
75	Westg.	CI-758-A	600
50	Westg.	MW-334	600
50	G.E.	HICTENV	600
35	G.E.	MTC-5536	600
20	Westg.	CI	1200
11	Westg.	CI-E464	900
10	P & H	BW-6	1800
5	P & H	BW-6	1200
5	N. West.	WRC	1200
3	G.E.	MTC-5944	900

SYNCHRONOUS MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 volts or higher)

HP	Make	Type	P.F.	Speed
1400	Westg.	HG	.7	900
400	Westg.	HG	1.0	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
275	*G.E. (2)	ATI	1.0	450
250	Al.-Ch.	SYN	1.0	1200
225	G.E.	TS-6244	1.0	300
225	Elec. Mchy.		1.0	360
190	Elec. Mchy.		1.0	720
150	Al-Ch. (2)	SYN	.8	1200
150	Fair.-Mor	TJC-285	.8	720
150	*Elec. Mchy.		.8	1200
150	Westg.	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6214	1.0	277
125	*Elec. Mchy.			900
115	Elec. Mchy.		1.0	240

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 volts or higher)

HP	Make	Type	Speed
1250	*Al-Ch. (3)	ANX	3600
1200	*Al-Ch.	ARW	1200
750	*Westg.	CS	900
500	*Al-Ch.	ARW	3500
500	Gen. Elec.	K-6345	1200
500	G.E.	KT-424	450
350	*G.E.	KT-559A	1800
250	West CS-8120S	TEFC	1800
250	G.E. (2)	KT-559	1800
250	*L-Allis	OEX-143	720
250	*G.E.	1K	600
250	G.E.	IK-17A	600
250	Westg.	CS-14	514
200	*G.E.	FT-549Y	3600
200	*G.E.	IK-13B	1800
200	G.E.	IK-16	1200
200	*Al-Ch.	ANZ-TEFC	900
200	*Westg.	CS-930A	900
200	G.E. (2)	KF-564S	720
200	*Al-Ch.	AN	720
200	Westg.	CS-1010	600
200	Al-Ch.	ARWWT	600
150	Cr. Wh.	SC-149 Vert	3450
150	G.E.	1E-13B	1200
150	*Al.Ch.	AN-30F	1200
150	G.E.	IK-15A	900
150	*G.E.	CS	600
125	*Westg.	CS-771 Sppf.	1800
125	*Al-Ch.	AR	1800
125	Westg. (2)	CS-761S	1750
125	Cr-Wh. (2)	Size 5QR	1200
125	G.E.	K-558	900
125	Al-Ch.	AN	514
100	Westg. CS	5075 TEFC	3600
100	*Westg.	CS-760A	1800
100	*G.E.	FT-542Z	1800
100	G.E.	FTRP-543	1800
100	Al-Ch.	ARZ-826FS	1200
100	*Westg.	CS-760D	1200
100	G.E.	KT-553	1200
100	Al-Ch.	AW-23D86	1200
100	*G.E.	KF-556	900
75	G.E. (2)	FT-529Y	3600
75	Al-Ch. (3)	AR-445S	3600
75	G.E.	KG-445	1800
75	G.E.	KT-537	1800
75	*Al-Ch.	AR505S	1765
75	G.E.	KT-546S	1200
75	*G.E.	KF-542	1200
75	Westg.	CS-664C	1200
75	Al-Ch.	APZ-505	1200
75	G.E.	KT-342	1200

MOTORS DIRECT CURRENT

H.P.	Make	Type	Speed
250	Westg.	SK-220	450/600
200	Rel. (2)	1400T	850/1200
200	Westg.	SK-201	650
200	Cr.-Wh.	CM	500
175	G.E.	ETC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	380/1000
50	Cr.-Wh.	CMC	700/1100
35	West (2)	SK-150	350/1000
30	Cr.W.	CCM-504	450
30/40	G.E. (2)	CD-123	400/1800
30/40	G.E.	CD-115	500/1500
25/30	G.E. (2)	RF-12	500/1500
25	G.E.	RC-32	800
25	Westg.	SK-133	575
20/25	Westg.	SK-151L	250/1000
20	Star	SB-10	1750
15	Westg.	SK-103	400/1800
10/15	Reliance	185T	400/1800
10/15	Westg.	SK-121	250/1000

MOTOR-GENERATOR SETS

KW	Make	A.C.	D.C.
1250	Westg.	6600/4160	600
1000	G.E.	12000	600
500	G.E.	4160/2300	250
400	A.C.	2300	120/240
300	G.E.	440	250
250	G.E.	440	250
200	G.E.	2300	250/275
200	Westg.	2300/4000	250/275
200	Ridgeway	2300	250
170	G.E.	440	125
150	G.E.	2300	125/250
150	A.C.	2300	275
150	Westg.	2300	125/250
150	G.E.	440	275
125	Cr-Wh. (3)	4160	125
100	G.E.	2300	250
100	Al-Ch.	2300	250
100	Elec.-Mach.	440	125
100	G.E.	440	125
90	G.E.	220/440	125
75	G.E.	440	125
50	Reliance	440	250
50	Ideal	2300	250
50	Westg.	220/440	250
50	Westg.	240	125
50	G.E.	440	125
40	G.E.	440	125
25	Westg.	220	275
20	G.E.	440	250
20	Rogue-G.E.	440	125
20	G.E.	220/440	250
15	Westg.	220/440	250
15	Ideal	440	125

DYNAMOMETERS

HP	Make	Type	Speed
125	G.E. Cr.	TLC-20	2700/6000
150	G.E. 3 Cr.	TLC-30	2500/5000
200	Westg.-Sk.	SK-151	1350/4000

PLATERS

AMP	MAKE	VOLTS
7500/3750	Elec. Prod.	6/12-220/440
7500/3750	Chandy.	12/24-220/440
6000/3000	Chandy.	12/24-220/440
2000/1000	Chandy.	6/12-220/440
1500/750	Chandy.	12/24-220/440
1500/750	Chandy.	6/12-220/440
1000/500	Chandy.	12/24-220/440

TRANSFORMERS

KVA	MAKE	TYPE	VOLT
1000	G.E. (3)	Oil	13200-2300
1000	Wagner (3)	Oil	13800-240/480
833	G.E. (3)	Oil	13800-480
667	Al. Ch. (3)	Oil	34500-2400/4160Y
677	G.E. new (1)	Oil	33000-480
500	G.E. (3)	Oil	13800-480/230
333	Al-Ch. (3)	Oil	13200-2400
250	Westg. (3)	Oil	2400/4160-480/240
150	Chg. El. (3)	Air	2300-110/220
100	Al. Ch. (3)	Oil	2400-240/480
100	Jeff. (3)	Air	2400-220/110
100	Moloney (2)	Oil	2300-220/110
100	G.E. (2)	Oil	2300-115
100	G.E. (1)	Oil	2400-120/240
100	Pitts. (3)	Oil	2400-575
100	Pitts. (1)	Oil	2400-120/240
75	G.E. (3)	Oil	2400-120/208
50	West. (3)	Oil	7200/12470-120/240
50	West. (2)	Oil	2300/1150-115

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1—7500 KW 2400/4160 volt Condensing—400#—700° FTT. New 1949

1—3500 KW 2400/4160 volt Condensing—400#—700° FTT. New 1941

1—1000 KW—240/480 volts—130/250# Cond. Auto. Extraction—15#—New 1945

1—1000 KW 480 volts—225# Condensing Auto. Extraction—20#

1—1250 KW 480 volts N. Cond. 150#—15# B.P.

1—300 KW — 480 volts — 210# Condensing Auto. Extraction—40#

1—250 KW—240 volts—130#—Non-Cond. 10/12# Back pressure

TRANSFORMERS

1—500 KVA 4160/480 V. Pyranol. 3 ph.

3—1667 KRH—13800/600 volts New 1948

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TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	750	G.E.	H	1	4600-120/240
1	750	G.E.	HT	3	4150Y-220/440
2	250	G.E.	H Pyranol	1	2400-4800-8320Y-120/240
2	250	West.		1	2300/4600-230/460
3	200	West.	S	1	2400/4160-240/480
3	200	G.E.	H	1	7800/15600-220/440
1	150	Elsler	OA	1	4160-240/480
2	3000	Maloney	TCR	3	7200/6600-4160/2400
3	50	Niagara	Air Cld	1	2300-120/240
2	37½	West.	Hypersil	1	2400/4160-240/480
4	25	West.	Hiperiol	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240
6	15	Maloney	KL	1	2400/4160Y-120/240

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	125	G.E.	600	TS	2300
1	125	E.M.	900		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
1	300	E.M.	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
1	15	G.E.	900	MT-542	440
1	25	G.E.	900	MT-526	440
1	60	G.E.	1800	MT	220
1	60	Ideal	900	AV	220
1	75	G.E.	600	IM	440
3	150	Allis-Ch.	1800	AY RW	220
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	25	G.E.	1170	405TEFC	220/440
1	40	Wagner	1750	CPI-444	440
				TEFC B.B.	
2	75	West.	1180	CS-607	440
1	100	G. E.	1775	KTP-543	440
1	40	Wagner	1200	CPI-445	440
				TEFC B.B.	
1	150	G.E.	720	KT-562	440
2	250	G.E.	1790	K.T.E.F.C.	2300
1	275	G.E.	1200	KT559B8	2200
2	300	G.E.	1800	K-4150Y	new
1	400	Cont.	1200	N806S	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	Volts DC	Volts AC
1	10	G.E.	1800	125	220/440 A.C.
3	60	E.M.	1200	125	220 v. Syn.
1	150	Cr. Wh.	600	125	220/440
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	75	C.W.	900	WP
1	125	G.E.	1700	RC
2	150	C.W.	900	WP
1	250	Allis Ch.	1750	FBL149BB

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	565	440
2	300	G.E.	ITC-5617	600	440

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1200 HP, 4 cylinders, 19" x 16", 327 RPM Skinner Vertical Universal Unaflow non-condensing engine Serial No. 11201, 160-175# PSI operating pressure, 25 to 30# gauge back pressure, direct connected to a:

1000 KVA—800 KW, 80% P.F., 40°C Rise, 327 RPM, 3 phase 60 cycle, 480 volt General Electric alternating current generator Serial No. 5319315, complete and equipped with its exciter, switchboard with instruments, including voltage regulator.

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37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	2300	Whse.	900
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
250	2200/440	G.E.	1200
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	440/220	Whse.	720
150	2200/440	G.E.	600
125	2200	G.E.	600
100	440/220	G.E.	720

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
250	440/220	G.E.	ATI	600
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G.E.	FT	3600
500	2200/4000	Elliott	SC	1800
350	2200	G.E.	IM	600
350	440	G.E.	KT	1200
300(2)	2200	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440/220	G.E.	KT	720
250	2300	Whse.	CS	600
200	440/220	G.E.	KT	1800
200	2200	G.E.	KT	1800
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	720
125	2200/440	G.E.	K	900
100(2)	4000/2300	L. Allis	OX	1200

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—360 kva, 900 rpm, 2200 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—187 kva., 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—1600 amp. ITE, 3 pole, 600 V
6—FKR-155-25, 600 amp., 15,000 V, G.E.
1—400 Amp., Condit, 3P, 25 KV outdoor
1—400 Amp. R. Smith, 3P 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	1800
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	850

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
150	Whse.	440/220	Sq. Ca.	275
125	G.E.	4000/440	Syn.	125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250
125	G.E.	440	Sq. Ca.	250/125

TRANSFORMERS 60 Cy.

1—1000 kva, Whse., 13,800—2300 V., 3 ph., New
1— 600 kva, Standard, 13,800—2300 V., 3 ph.
3— 500 kva, G.E., 13,800—2300 V.
3— 333 kva, G.E., 13,800—2300 V.
2— 300 kva, G.E., 4150—240 V., 3 ph., Pyr.
3— 200 kva, Mol., 13,800—2300 V.
3— 150 kva, Al. Ch. 2400—220 V.
3— 150 kva, Al. Ch. 440-220 V., dry, New
3— 100 kva, G.E., 2400—240/480, V New
3— 333 kva, G.E., 13,200—480 V.
3— 150 kva, G.E., 13,200—2300 V.
3— 100 kva, G.E., 2400—120/240 V., Pyr.

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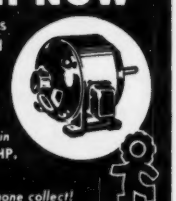

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80000#/HR. BOILER

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400 HP BOILER (2)

B&W 160 PSI Oil & Gas fired ASME, New 1947.

DIESEL GENERATOR

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D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	G.E. dynamom.	TLC	250	1150/2500
200	Allis Ch. b.b.	EW	230	600/900
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
150	C.W. TEFC b.b.	83H	230	800
100	Reliance	651-T	550	1000/1600
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Century	R-92	230	690/1350
75	Reliance (3)	985-T	230	450/1200
60	G.E. TEFC b.b.	CD-135	230	1150
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E.	CD-125	230	400/1200
50	G.E.	HF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	Whse. (2)	SK-151	230	250/1000

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	2200 AC	250 DC
250	Cr. Wh.*	440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.	2300 AC	250 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.*(2)	220/440 AC	250 DC
75	G.E. converter	440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Whse.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
30	G.E.	220/440 AC	125 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
75	Century	R-92	250	900
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
45	Allis Ch.	E-122	250	1800

TRANSFORMERS—3—150KVA Kuhlman OISC, 1 ph. 60 cycle, 2400—240/480, late type.

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
500	G.E.	Sq. Cage	4000	1800
500	Whse.	Slipring	2200	450
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	Whse.	Sq. Cage	2200/440	720
300	Whse.	Synch.	440	1200
300	G.E.	Slipring	440	450
250	Ideal	Slipring	2200	900
250	G.E.	Slipring	440	1800
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Gen. Elec.	Synch.	220/440	450
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	G.E. (2)	Sq. Cage	2200/440	1200
200	Whse. (2)	Slipring	2200	514
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
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150	G.E.	Slip Ring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
150	Allis Ch. b.b.	Sq. Cage	2200/440	720
125	Whse. TEFC	Sq. Cage	2200/440	720
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
100	Al. Ch. TEFC	Sq. Cage	2200/440	720

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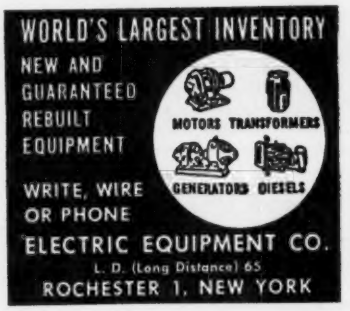

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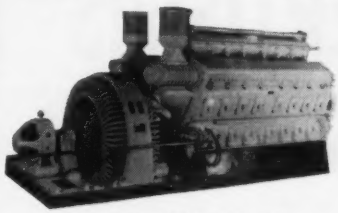
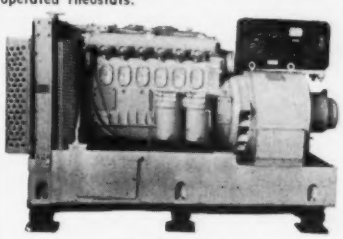


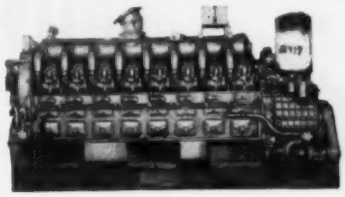
G.M. 16-567—1250 KVA—A.C.

1250 KVA 4600/2300 volt 3 phase 60 cycle 720 RPM Westinghouse sync. A.C. generator—80% P.F.—S.O. 6P455 with direct connected 10 KW exciter. Spare parts include (1) factory reconditioned blower; (1) extra blower; and a quantity of new pistons, liners, heads, bearings, etc. Unit complete with Westinghouse oil circuit breaker —15000 volts—type F-124—600 amps—60 cycle —solenoid operated—mounted in drawer-type cubicle 20" wide—44¼" deep—88" high. Motor operated rheostats.



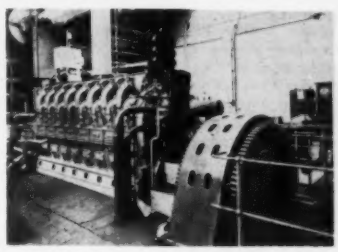
G.M. 6-71—60 K.W.—A.C.

GM 6-71 radiator cooled self-contained diesel generator sets—60 KW 440 or 220 volts 60 cycle 3 phase 1200 RPM with direct connected exciters and self-contained panel boards, including rheostats, SilverStat voltage regulator, ammeters, voltmeters. These units are guaranteed to be in perfect running condition and can be demonstrated at our plant. The generators were made by Delco and are ball-bearing drip-proof marine type. Engines are famous GM 6-71 6-cylinder 2-cycle 4¼ x 5—equipped for electric starting. Equipped with radiator, self-contained fuel tank, all controls, etc. Mounted on pre-fab sub-base. 8 available.



G.M. 16-278A—1200 KW—D.C.

(1) 16-278A diesel generator set. GENERATOR: 1200 KW—525 volts DC—3000 amps—720 R.P.M. —shunt wound. (Generator not shown) ENGINE: #11977—complete with full flow filters; Harrison heat exchangers; strainers; pyrometers, etc. 1600 HP at 720 RPM—formerly in Navy DE. Never in commercial use. Generator is totally enclosed air-cooled drip-proof marine type mfg. by Allis-Chalmers. Excellent for dredges and other DC requirements.



1250 KVA DIESEL A.C. POWER PLANT

Modern 1250 KVA 1000 KW 420 volt 3 phase 50 cycle 4-wire diesel driven alternator set, mounted on a fabricated baseplate and direct coupled at 750 RPM, incorporating: ENGINE—G.M. 16-278A —#11691, dated 1943; 1700 b.h.p. 16-cylinder 2-stroke cycle; cold starting; cylinders 8¾" x 10½"; complete with hydraulic governor and overspeed trip. Direct coupled to: ALTERNATOR —by Electric Machinery Co—#97688. Revolving field, 0.8 P.F.; 1720 amp. per phase; 750 RPM; single pedestal oil ring lubricated bearing; direct coupled exciter 12.5 volts 52 amps. Engine has standard fittings and ancillaries.

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Full power total	253,000 lbs./hr.	Economizer surface	3843 sq. ft.

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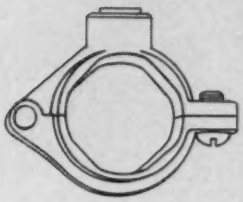

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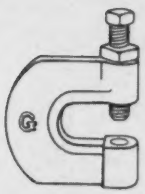

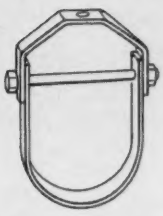

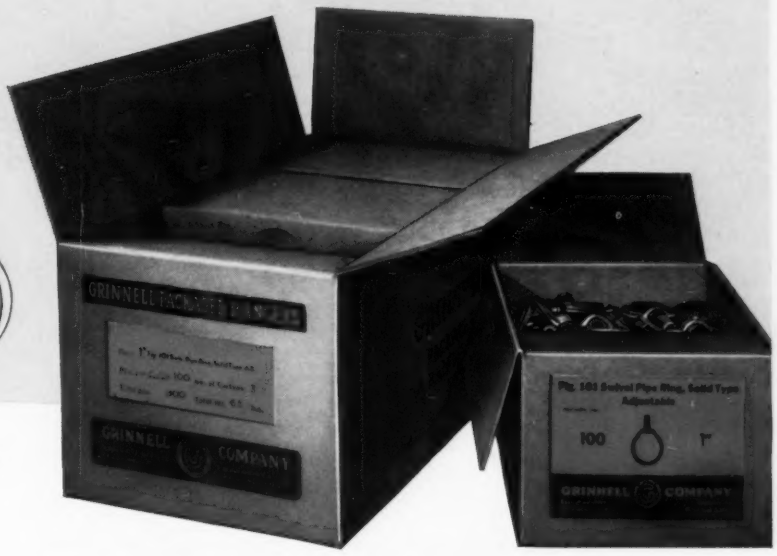

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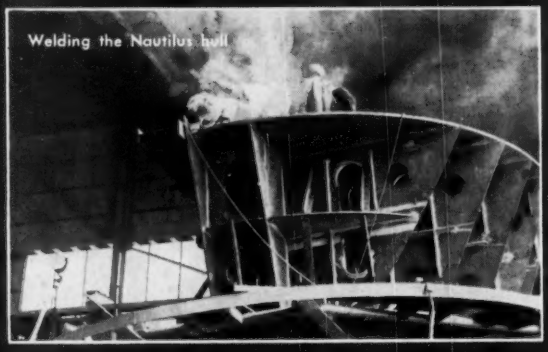

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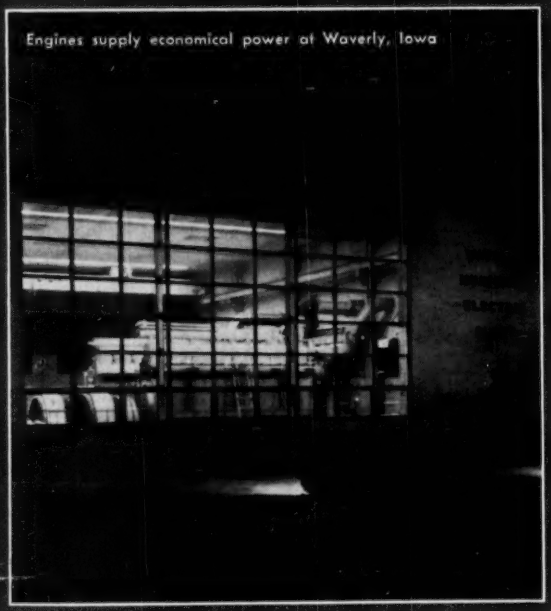

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